GENERAL ANATOMY,

APPLIED TO

PHYSIOLOGY AND MEDICINE;

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MUSCULAR SYSTEM OF ORGANIC LIFE.

THIS system is not as abundantly spread out in the economy as the preceding. The whole mass which it forms, compared with the whole of the other, which is more than one third of the body, presents in this respect a very remarkable difference. Its position is also different; it is concentrated, 1st, in the thorax, where the heart and oesophagus belong to it; 2d, in the abdomen where the stomach and intestines are in part formed by it; 3d, in the pelvis where it contributes to form the bladder and even the womb, though this belongs to generation, which is a function distinct from organic life. This system then occupies the middle of the trunk, is foreign to the extremities, and is found far from the action of external bodies, whilst the other superficially situated, forming almost alone the extremities, seems, as we have said, almost as much destined in the trunk to protect the other organs, as to execute the different motions of the animal. The head contains no part of the organic muscular system; this region of the body is wholly devoted to the organs of animal life.

ARTICLE FIRST.

OF THE FORMS OF THE MUSCULAR SYSTEM OF ORGANIC LIFE.

All the muscles of the preceding system take in general a straight direction. These are all on the contrary curved upon themselves; all represent muscular cavities differently turned, sometimes cylindrical as in the intestines, sometimes conical as in the heart, sometimes rounded as in the bladder, and sometimes very irregular as in the stomach. No one is attached to the bones; all are destitute of tendinous fibres. The white fibres arising from the internal surface of the heart, and going to be attached to the valves of its ventricles, have by no means the nature of the tendons. Ebullition does not easily reduce them to gelatine; desiccation does not give them the yellowish appearance of these organs; they resist maceration longer than them.

It is in general a great character that distinguishes the muscular organic system from that of animal life, that it does not arise from, nor terminate in fibrous organs. All the fibres of this last are continuous either with tendons, or aponeuroses or fibrous membranes. Almost all those of the first go on the contrary from the cellular texture, and return to it after having run their course. I at first thought that the dense and compact texture which is between the mucous membrane and the fleshy fibres of the intestines, the bladder, the stomach, &c. was an assemblage and net-work of many small tendons corresponding to these fibres, and interwoven in the form of an aponeurosis; the density of this layer deceived me at first view. Ebullition, maceration, and desiccation have since taught me, that this layer, completely foreign to the fibrous system, should be referred, as Haller has said, to the cellular,

which is only more dense and compact there than elsewhere. It is this layer, which I have designated, in the cellular system by the name of the sub-mucous texture. Many fibres of the system of which we are treating appear to form an entire curve, which is not crossed by any cellular intersection; some layers of the heart exhibit this arrangement, which is in general very rare; so that there is almost always an origin and termination of the fibres, upon an organ of a nature different from their own.

We can hardly consider in a general manner the forms of the system of which we are treating; each organ belonging to it is moulded upon the form of the viscus to the formation of which it contributes. In fact, the organic muscles do not exist in distinct fasciculi, like those of animal life; all, except the heart, form but a third, a quarter and often even less in the structure of a viscus.

The greatest number has a thin, flat and membranous form. There are layers more or less broad, and hardly ever distinct fasciculi. Placed at the side of each other, the fibres are rarely one above another; hence it happens that occupying a very great extent, these muscles form however a very small volume. The great gluteus alone would be larger than all the fibres of the stomach, the intestines and the bladder, if they were united like it into a thick and square muscle.

ARTICLE SECOND.

ORGANIZATION OF THE MUSCULAR SYSTEM OF ORGANIC LIFE.

The organization of the involuntary muscles is not as uniform as that of the preceding. In these all is exactly

similar excepting the differences of the proportion of the fleshy fibres to the tendinous, of the length of the first, of the prominence of the fasciculi, of their assemblage into flat, long or short muscles; in whatever place we examine them, their varieties are in their forms and not in their texture. Here on the contrary, there is in this texture marked differences; the heart compared with the stomach, the intestines with the bladder are sufficient to convince us of this. It is by virtue of these different textures, that the contractility and sensibility vary as we shall see in each muscle, that the force of the contraction is not the same, and that life is different in each, whilst it is uniform in all those of animal life. We shall now consider in a general manner the organization of the involuntary muscles.

I. *Texture peculiar to the Organization of the Muscular System of Organic Life.*

The organic muscular fibre is in general much finer and more delicate than that of the preceding system; it is not brought into as thick fasciculi. Very red in the heart, it is whitish in the gastric and urinary organs. Besides, this colour varies remarkably. I have observed that sometimes maceration renders it of a deep brown in the intestines.

This fibre never has one single direction, like that of the preceding muscles; it is interlaced always, or found in juxta-position in different directions; sometimes it is at a right angle that the fasciculi are cut, as in the longitudinal and circular fibres of the gastric tubes; sometimes it is with angles more or less obtuse or acute, as in the stomach, the bladder, &c. In the heart, this interlacing is such in the ventricles, that it is a true muscular net-work. From these varieties of direction, results an advantage in the motions of these sorts of muscles, which, being all

hollow can by contracting diminish according to many diameters the extent of their cavity.

Every organic muscular fibre is in general short; those which, like the longitudinal of the œsophagus, the rectum, &c. appear to run a long course, are not continuous; they arise and terminate at short distances, and thus arise and terminate successively in the same direction or line; no one is comparable to those of the sartorius, the gracilis, &c. as it respects length.

We know the nature of their fibres no better than that of those of animal life; but they appear nearly the same under the action of the different reagents. Desiccation, putrefaction, maceration, ebullition, exhibit in them the same phenomena. I have observed upon the subject of this last, that once boiled, the fibres of both systems are much less alterable by the acids sufficiently weakened. After being some time in the sulphuric, the muriatic and nitric diluted with water, they soften a little, but keep their orignal form, and do not change into that pulp to which raw fibres are always reduced in the same experiment. The last of these acids turns them yellow as before ebullition.

I have also made an observation as it respects the horny hardening which is produced the instant ebullition commences; it is this, that it is always the same whatever may have been the antecedent dilatation or contraction of the fibres. The stomach which at death was so dilated as to contain many pints of fluid, is reduced to the same size, all other things being equal, as that which is contracted so as to be no larger than the cœcum. Diseases have a little influence on the horny hardening. The heart of a phthisical patient exhibited to me in the same experiment this phenomenon much less evidently, than that of an apoplectic.

The resistance of the organic muscular fibre is in proportion much greater than that of the fibres of the animal

muscular system. Whatever may be the distension of the hollow muscles by the fluid which fills them during life, ruptures hardly ever take place in them.

The bladder alone sometimes exhibits this phenomenon, which is however very rare in it. In the great retentions of the urine, in which ruptures take place, it is almost always the urethra that is ruptured, and the bladder remains whole. We meet in practice with a hundred fistulas in the perineum, coming from the membranous portion, to one above the pubis. We find in authors many examples of rupture of the diaphragm ; we know of but few of the rupture of the stomach, the intestines and the heart.

II. *Common Parts in the Organization of the Muscular System of Organic Life.*

The cellular texture is in general much more rare in the organic muscles than in the others. The fibres of the heart are in juxta-position, rather than united by this texture. It is a little more evident in the gastric and urinary muscles. It is almost wanting in the womb ; thus these muscles are not infiltrated, like the preceding, in dropsies ; they never exhibit that fatty state of which we have spoken, and which sometimes loads the fibres. I have not observed in these fibres the yellowish tinge which the others often take, especially in the vertebral depressions.

The blood vessels are very numerous in this system ; they are found in it even in greater proportion than in the other ; more blood consequently penetrates them. This fact is remarkable, especially in the intestines, in which the mesenteric arteries distribute numerous branches, over an extremely delicate fleshy surface. But I would remark that this appearance is to a certain degree deceptive, as many of these vessels only traverse the fleshy surface to go to the mucous membrane. In the ordinary state they give to the gastric viscera a reddish tinge, which I have rendered at will livid and afterwards brought back to its

primitive state, by shutting and afterwards opening the stop-cock adapted to the wind pipe, in my experiments upon asphyxia.

The absorbents and exhalants have nothing peculiar in this system.

The nerves come to them from two sources; 1st, from the cerebral system; 2d, from that of the ganglions.

Except in the stomach in which the par vagum is distributed, the nerves of the ganglions predominate everywhere. In the heart, they are the principal; in the intestines, they are the only ones; at the extremity of the rectum and the bladder, their proportion is greater than that of the nerves coming from the spine.

The cerebral nerves intermix with them, in penetrating the organic muscles. The cardiac, solar, hypogastric, plexuses, &c. result from this intermixture which appears to have an influence upon the motions, though we are ignorant of the nature of this influence.

All the nerves of the ganglions which go to the organic muscles, do not appear to be exclusively destined to them. A great number of filaments belong only to the arteries; such is in fact their interlacing, that they form, as we have seen, around these vessels a real nervous membrane, superadded to their own, and exclusively destined to them. I would compare this nervous envelope to the cellular envelope which is also found around the arteries, and which is wholly distinct from the surrounding cellular texture; thus it only has communications with the nerves of the organic muscles, without being distributed to these muscles. Besides as the nerves of the ganglions are always the most numerous and essential in them, and as their tenuity is extreme, the nervous mass destined to each is infinitely inferior to that which is found in the voluntary muscles. The heart and the deltoid muscle compared together, exhibit in this respect a remarkable difference.

ARTICLE THIRD.

PROPERTIES OF THE MUSCULAR SYSTEM OF ORGANIC LIFE.

Under the relation of properties, this system is in part analogous to the preceding, and in part very different from it.

I. *Properties of Texture. Extensibility.*

Extensibility is very evident in the organic muscles. The dilatation of the intestines and the stomach by aliments, by the extrication of gas, by the fluids that are found there, that of the bladder by the urine, by injections that are forced in, &c. are essentially owing to this extensibility.

This property is characterized here by two remarkable attributes; 1st, by the rapidity with which it can be put into action; 2d, by the very great extent of which it is susceptible.

The stomach and intestines pass in an instant from complete vacuity to great extension. Artificially distended, the bladder becomes immediately of a size treble, quadruple even of that which is natural to it. It sometimes however resists, but this does not prove its defect of extensibility; it is because the fluid injected irritates it and makes it contract; the organic contractility in exercise, then prevents the development of extensibility, as it sometimes cannot be brought into action by stimulants in a muscle laid bare, because the animal contractility in exercise in the muscle, forms an obstacle to it. The muscles of animal life are never capable of this rapidity in their

extensibility, whether because they are intersected by numerous aponeuroses which dilate but slowly, or whether because their layers of fibres are very thick, two circumstances that do not exist in the muscles of organic life. Hence a remarkable phenomenon that I have observed in all cases of tympanites. When we open the abdomen of subjects that have died in this state, without wounding the swelled intestines, these immediately burst out, swell more, and occupy twice as large a space as they were contained in in the abdomen; why? Because the parietes of the abdomen being unable to yield in proportion to the quantity of gas that is developed, this has been compressed in the intestines during life, and expands immediately by its elasticity when the cause of compression ceases. In dropsies in which the distension is slow, the abdominal parietes enlarge much more than in tympanites. The size of the abdomen would be double in this, if the extensibility of the parietes was in proportion to that of the intestines.

As to the extent of the extensibility of the organic muscles, we can form an idea of it by comparing the empty stomach which oftentimes is not larger than the cæcum in its ordinary state, with the stomach containing sometimes five, six and even eight pints of fluid; the bladder contracted and concealed behind the pubis, with the bladder full of urine from suppression, rising sometimes even above the umbilicus; the rectum empty, with the rectum filling a part of the pelvis in old people in whom the excrements have accumulated in it; the intestines contracted with the intestines greatly distended.

It is to the extent of extensibility of the organic muscles and to the limits placed to that of the abdominal parietes, that must be referred a constant phenomenon that is observed in the gastric viscera; viz. that in the natural series of their functions, they are never all distended at the same time; the intestines are filled when

the matters contained in the stomach are evacuated; the bladder is not full of urine in the digestive order, until the other hollow organs are empty, &c. In general, that is an unnatural order in which all the organs are distended at once.

There is for the organic muscles a mode of extensibility wholly different from that of which I have just spoken; it is that of the heart in aneurisms, and the womb in pregnancy. The first, for example, acquires a size double, treble even sometimes in its left side, and yet it increases at the same time in thickness. This size is not owing to distension, but to a preternatural growth. The aneurismatic heart is to the ordinary heart, what this is to the heart of the infant; it is nutrition that makes the difference and not distension; for whenever it is owing to this it diminishes in thickness as it increases in extent; there is no addition of substance. Besides the aneurismatic heart has not often the cause that distends it, for commonly in this case the mitral valves allow a free passage to the blood; whilst when they are ossified the left ventricle often remains in a natural state. Moreover, the slow progress of the formation of aneurism proves that it is a preternatural nutrition that has presided over this increase of the heart. You would in vain then empty this organ of the blood it contains, it would not contract and resume its dimensions, as the inflated intestine does which we puncture to allow the air to escape.

In the womb there are two causes of distension; 1st, the sinuses greatly developed; 2d, an addition of substance, a real momentary increase of the fibres of the organ which remains as thick and even more so than in the natural state. At the time of accouchement, the sinuses immediately flatten by the contraction of the fibres; hence the sudden contraction of the organ. But as on the one hand nutrition alone can remove by decomposition the substances added to the fibres to enlarge

them, and as on the other, this function is exerted slowly, after the womb has undergone the sudden contraction owing to the flattening of its sinuses, it returns but gradually and at the end of some time to its ordinary size. Extensibility is not then brought into action in the womb filled by the fœtus, and in the aneurismatic heart; these organs really become at that time the seat of a more active nutrition; they grow preternaturally, as they have grown naturally with the other organs; but these do not then experience an analogous phenomenon, they become monstrous in comparison. The womb decreases, because the motion of decomposition naturally predominates over that of composition after accouchement, whilst it was the reverse before this period. The aneurismatic heart remains always so.

These dilatations of the heart should be carefully distinguished from those really produced by extensibility, as in the right auricle and ventricle for example, which are found full of blood at the moment of death, because the lungs which are weakened, not allowing it to pass through them, compel it to flow back to the place from which it came. There are but few hearts which do not exhibit in very various degrees, these dilatations, which we have the power in a living animal of increasing or diminishing at will, according to the kind of death we produce. Two hearts are hardly ever of the same size after death; many varieties are met with, and these depend more or less on the difficulties which the blood experiences in the last moments, in passing through the lungs. Hence why in the diseases of the heart, there is no standard by which we can compare the morbid size, especially if we examine the organ as a whole. In fact the distension of the right side can give it an aneurismatic appearance, and a size even greater than that of some aneurisms. If we examine the left side separately, the error is more easily proved, because this side is subject

to less variations. But the principal difference consists in the thickness. The power of contraction appears to increase in proportion to this thickness, which arises from the substance added by nutrition. It is this power which produces the great beating that is felt under the ribs, the strength of the pulse, &c.

Contractility.

It is in proportion to extensibility. It is often brought into action in the ordinary state. It is in virtue of this property, that the stomach, the bladder, the intestines, &c. contract, and acquire a size so small compared to what they have when they are full. In general, there is no muscle of animal life, which is capable of such extreme contractions as those of organic life.

It should be remarked, however, that life, without having contractility immediately dependant upon it, since the intestines, the stomach, and the bladder contract after death when their distension is removed, modifies it in a very evident manner. The causes even which alter or diminish the vital forces have an influence upon it; hence the following observation that all those accustomed to open dead bodies can make. When the subject has died suddenly, and the stomach is empty, it is much contracted; when, on the contrary, death has been preceded by a long disease which has weakened its forces, the stomach, though empty, remains flaccid, and is found but very little contracted.

We should consider the substances contained in the hollow muscles of organic life, as true antagonists of these muscles; for they have not muscles that act in a direction opposite to theirs. As long as these antagonists distend them, they do not obey their contractility of texture; when they are empty, this is brought into action. It is not, however, upon this property that the mechanism of the expulsion of matters from these organs turns, as

aliments from the stomach and intestines, urine from the bladder, blood from the heart, &c. It is the organic contractility that presides over this mechanism. It is difficult to distinguish these properties in exercise. One occasions a slow and gradual contraction, which is without the alternation of relaxation ; the other, quick and sudden, consisting in a series of relaxations and contractions, produces the peristaltic motion, those of systole, diastole, &c. It is after the organic contractility has procured the evacuation of the hollow muscles, that the contractility of texture closes them. In death from hemorrhage from a great artery, the left and even the right side of the heart send out all the blood they contain ; afterwards empty, they contract powerfully, and the organ is very small. On the contrary, it is very large when much blood remaining in its cavities, distends it, as in asphyxia. These are the two extremes. There are, as I have said, many intermediate states.

The contractility of texture is, in the system of which we are treating, in proportion to the number of fleshy fibres. Thus, all things being equal, the rectum, when empty, contracts upon itself with much more force than the other large intestines ; the contraction of the ventricles is much greater than that of the auricles, and that of the œsophagus is much greater than that of the duodenum, &c. &c.

II. *Vital Properties.*

They are almost in an inverse order of those of the preceding system.

Properties of Animal Life. Sensibility.

The animal sensibility is slight in the organic muscles. We know the observation related by Harvey upon a caries of the sternum that laid bare the heart; they irri-

tated, without its being felt by the patient, this organ, which only contracted under the stimulant. Remove the peritoneum behind the bladder of a living dog, and irritate the subjacent muscular layer, the animal gives but few marks of pain. It is difficult to make these experiments upon the intestines and the stomach; their muscular coat is so delicate that we cannot act upon it without at the same time stimulating the subjacent nerves.

It appears that the organic muscles are much less susceptible of the feeling of lassitude, of which the preceding become the seat after great exercise. I do not know however if in those to which many cerebral nerves go, it does not take place; for example, when the stomach has been for a long time contracted, it is probable that the lassitude of its fibres, produces in part the painful sensation that we then have, and which we call hunger, a sensation that should be distinguished from the general affection that succeeds it, and which becomes truly a disease, when abstinence has been too much prolonged. We know that substances not nutritive then appease this sensation without remedying the disease, when the stomach is filled with them. I refer to the same kind of sensibility the anxiety and distress which patients experience, in whom we keep the bladder in permanent contraction by an open sound in the urethra, which transmits the urine as fast as it falls from the ureters. This sensation does not resemble that of hunger, because the sensibility of the bladder and that of the stomach being different, their modifications cannot be the same. Thus each of these two sensations is different from that of which the muscles of animal life, for a long time contracted, become the seat. I do not believe that the sensation of hunger belongs solely to the cause I have pointed out, and which others have not spoken of; but it cannot be denied that it has much part in it. Who knows if, after a fever in which the action of the heart has been for a long time

accelerated, the weakness of the pulse which accompanies convalescence, is not a sign of the lassitude in which its fleshy fibres are, on account of the antecedent motion? We know the painful sensation of fatigue which the stomach experiences after the contractions of vomiting.

Contractility.

The animal contractility is foreign to the muscles of organic life. To be convinced of this, we must recollect that on the one hand this contractility always supposes the influence of the brain and the nerves, to bring in play the action of the muscle, and that on the other, the brain, in order to exert this influence, must be excited by the will, by stimulants or by sympathies. Now none of these causes acting upon the brain, the organic muscles cannot contract.

Every body knows that these muscles are essentially involuntary. If some men have had the faculty of arresting the motions of the heart, it is not upon this organ that the brain has acted; the action of the diaphragm and the intercostals has first been suspended; respiration has ceased for a time; then consequently the circulation.

If we irritate the brain with a scalpel or any other stimulant, the muscles of animal life become convulsed; they are paralyzed if we compress this organ. Those of organic life, on the contrary preserve in both cases their natural degree of motion. The heart still continues to beat, the intestines and stomach move some time after the cerebral mass and spinal marrow have been taken away. Who does not know that the circulation goes on very well in acephalous fœtuses; that after the blow that has knocked down an animal, and rendered his whole voluntary muscular system immoveable, the heart is still for a long time agitated, the bladder rejects the urine, the rectum expels the excrements, &c. the stomach even sometimes vomits up aliments? Opium, which benumbs the

whole animal life, because it acts especially upon the brain which is the centre of it, which paralyzes all the voluntary muscles, leaves the others unaffected in their contractions. Intoxication produced by wine exhibits the same phenomenon. A man staggers after drinking; his limbs refuse to carry him, and yet his heart beats with force; his stomach often heaves and rejects the surplus fluids it contains. All narcotic substances also produce this effect.

If from experiments we pass to observations on the sick, we see that all cerebral affections are foreign to the organic muscular system. Wounds of the head with depression, fungi of the brain, effusions of blood, pus and serum, apoplexy, &c. affect exclusively the voluntary muscles, the action of which they increase, weaken or destroy. In the midst of this general derangement of animal life, the organic remains unaffected. The paroxysm of mania and malignant fever likewise proves this fact. Who does not know that in this last the pulse is oftentimes scarcely altered, that sometimes even it is slower?

Frequently in diseases of the head, there are spasmodic vomitings; the action of the heart is accelerated in cerebral inflammations, &c. But these are sympathetic phenomena which happen in the organic muscles, as they do in all the other systems; they may not appear nor be developed; a thousand irregularities are observed in their progress. Whereas the contraction of the muscles of animal life by affections of the brain is a constant, invariable phenomenon, which nothing disturbs, and the development of which nothing prevents, because the means of communication are always the same between the affected organ and the one that moves.

If in the examination of the phenomena relative to the cerebral influence upon the organic muscles, we follow an inverse order, that is to say, that in the affections of these muscles we examine the state of the brain, we observe the same independence; consider most vomitings, the

irregular motions of the intestines which take place in diarrhoeas, those especially which form the iliac passion, &c.; observe the heart in the agitations of fevers, in the irregular palpitations of which it becomes frequently the seat, &c.; in these derangements of the organic muscles, you will very seldom find signs of lesions of the cerebral organ; it is calm, while every thing is disordered in organic life. Cullen thought that in syncope the action of the brain ceased first, and that that of the heart was afterwards consequently suspended. It is precisely the reverse in the greatest number of cases. The heart, at first affected, ceases to act; now its action being essential to that of the brain, whether from the motion it communicates to it, or from the red blood it sends, the functions of this last are suddenly suspended and the whole animal life ceases. This is remarkable especially in the syncopes that arise from the passions, in those from hemorrhages, polypi, great evacuations, &c. I refer upon this subject to my Treatise upon Life and Death.

If from the influence of the brain we pass to that of the nerves, we find new proofs of the absence of animal contractility in the organic muscles. The most of these muscles receive, as we have seen, two species of nerves, the one cerebral, the other from the ganglions.

The heart, the stomach, the rectum and the bladder are evidently entered by the first species of nerves; now by cutting, or irritating in any way the cardiac filaments of the par vagum, the heart experiences no alteration from it; its motion is neither retarded, nor accelerated. The division of both branches of the par vagum is fatal, it is true, but not until after some days; and I doubt whether it is by the heart that death commences in this case. The principal phenomena consequent upon this division show a great embarrassment in the lungs, a great difficulty of breathing; the circulation appears to be troubled only in consequence.

The same nerves going to the stomach, the same experiment serves to prove the cerebral influence upon this viscus. Now the division of that of one side is usually nothing upon it; that of both soon produces a remarkable derangement in it. But this derangement is wholly different from that which follows the section of the nerve of a muscle of animal life, which becomes suddenly immoveable, whilst that on the contrary the stomach not communicating with the brain except by the par vagum, seems to acquire in an instant an increase of power; it contracts and hence the spasmodic vomitings that are almost always observed during the two or three days that the animal survives the experiment, vomitings that I have constantly noticed in dogs, and which Haller and Cruikshank had before observed. It appears then from this, that though the brain has a real influence upon the stomach, this influence is of a nature wholly different from that which it exerts upon the voluntary muscles. I would observe however that the irritation of one branch of the par vagum, or of both, makes the stomach immediately contract, as happens in a voluntary muscle when we irritate its nerve. It is necessary, in order to make this experiment, to open the abdomen of a living animal, and afterwards to irritate the eighth pair in the region of the neck, so as to have in sight the organ that we make contract.

The bladder and the rectum appear to approximate the voluntary muscles, in their relation with the brain, more than the stomach and the heart. We know that falls on the sacrum, from which arises a shock of the inferior part of the spinal marrow, produce retention of urine; that they strike, as it were, this organ with the same paralysis as the inferior extremities, which then also cease to move. Yet as the bladder is very powerfully assisted in its functions by the abdominal muscles, by the levator ani and other voluntary muscles which surround it, the immobility

of these muscles contributes much to the inability to evacuate the urine. That which makes me think so, is that, 1st, the irritation of the spinal marrow towards its inferior part which puts in motion all the voluntary muscles of the inferior extremities and of the pelvis, does not produce any effect upon this part. I have convinced myself of this fact many times upon dogs and guinea-pigs. 2d. By irritating the nerves coming from the sacral foramina and going to the bladder, nerves that it is often very difficult to find, on account of the blood in an animal recently killed, I have seen this muscle remain immoveable. On the contrary all these nerves having been cut, the injection of a fluid slightly stimulant makes it contract with force. 3d. In experiments upon living animals, as in surgical operations, the violence of the pain which sometimes produces spasmodic contractions of all the muscles of animal life, frequently occasions an involuntary discharge of urine. Now in these cases it is not the bladder that is convulsed; for if in an experiment this phenomenon takes place, open the abdominal parietes, in an instant the flow of urine ceases, because on the one hand the muscles of these parietes cannot act upon the intestines and press them against the bladder, and because on the other the levator ani which contracts and raises this organ, has no resisting point against which it can compress it above. Observe in fact that in strong jets of urine, the bladder is placed between two opposite efforts, one superior, which is the gastric viscera pressed by the diaphragm and the abdominal muscles, the other inferior, which is especially the levator ani which acts by contracting from below above, whilst the opposite effort acts from above below; now these two efforts are evidently under the cerebral influence. I have very frequently had occasion to observe the bladder full of urine in a living animal whose abdomen was opened; I have never seen it contract with sufficient violence to expel the fluid.

I do not deny but that the bladder, by the nerves it receives from the sacral plexuses, is to a certain extent a voluntary muscle; but I say that it is principally by forces accessory to its own and necessary to its functions, that it is subjected to the will; that the animal contractility is much greater in its functions than the sensible organic contractility. How then is the urine retained in this organ, or expelled from its cavity at will? In this way; when the urine falls into the bladder, and is there on the one hand but a short time, and on the other only in small quantity, it is not then an irritant sufficiently powerful to produce the exercise of the sensible organic contractility. The effort which the bladder makes is so small, that it cannot overcome the resistance of the urethra, which being shut by the contractility of texture, must be dilated by the impulse communicated to the urine. In order to void this fluid, there must then be added to the contraction of the bladder that of the surrounding voluntary muscles; now the least effort of these muscles is sufficient to overcome the resistance of the urethra. But if the urine is in great quantity in the bladder, and it has acquired by remaining in it a long time that deep colour which indicates the concentration of its principles, then the irritation that it produces on the organ brings powerfully into action the sensible organic contractility; the bladder contracts, and in spite of the animal, there is an evacuation of urine.

In the rectum, in which the excrements have not a long canal, but only a simple opening to pass, this is furnished with a sphincter which is wanting in the urethra. This sphincter habitually closed must be dilated by the impulse communicated to the excrements. When they are in the rectum a short time and in small quantity, the sensible organic contractility is not brought into action with sufficient power to expel them; it requires the action of the neighbouring voluntary muscles. If this

action is not determined by the influx from the brain, the excrements remain in the intestines; hence how, for some time, we retain them at will. But as they increase in quantity, and become more acrid by remaining and consequently more irritating, then the sensible organic contractility strongly brought into action, empties the intestine involuntarily. If the sphincter, which is voluntary, is paralyzed, there will be incontinence, because no resistance is opposed to the tendency of the rectum to contract, a tendency which though feeble as long as it is but partly filled, is however always real.

From what we have said, it appears evidently that the bladder and rectum, though receiving cerebral nerves, are yet less influenced by the brain than it at first view appears, and that there is evidently between them and the voluntary muscles a very great difference. They are not mixt, as it is called; they approach the organic muscles infinitely nearer than the others; I doubt even whether if no accessory power acted with and compressed them, the mind could by the nerves which come from the sacral plexuses, make them contract at will. I have never seen an animal void his excrements when the abdomen was open.

Let us conclude from all that has been thus far said, that the cerebral nerves which go to the organic muscles have upon them an influence which by no means resembles that of the cerebral nerves going to the muscles of animal life. I am ignorant moreover of the nature of this influence.

All the organic muscles receive nerves from the ganglions, both the preceding ones which are also penetrated by the cerebral nerves, and the small intestines, and the cœcum, colour, &c. which are exclusively pervaded by them. Now by cutting, tying or irritating in any manner these nerves, by stimulating the ganglions from which they go, by destroying or burning them with a concen-

trated acid or alkali, the muscle remains in its natural state; its contractions are neither accelerated nor retarded.

I have not been contented with ordinary agents in convincing myself of the deficiency of real action of the nerves upon the organic muscles; a fact, which all good physiologists have always admitted, notwithstanding the opinions hazarded by some physicians who apply the vague term of nervous influence to organs which are not susceptible of it.

I have then employed galvanism, and I am convinced that it has very little, almost no power, in putting into action muscular contractions in organic life, whilst it is the most powerful agent in animal life. I shall not here relate my experiments upon this subject; they will be read in my Researches upon Death.

We can conclude from all that precedes, that the cerebral and nervous influence upon the organic muscles is not known to us; that it does not act as upon the voluntary muscles. It is however real to a certain extent, since it is necessary that the nerves which enter into the composition of these muscles should be of some use; but we are ignorant of this use.

Organic Properties.

The organic sensibility is strongly characterized in the muscles of which we are treating. Before the sensible organic contractility is developed in them, it is necessary that this should be put in action. But as these two properties are not separated, as in their exercise they always succeed each other, what we are going to say of sensible organic contractility will apply also to the sensibility of the same nature.

Insensible organic contractility or tone, exists in the muscular system, to a degree necessary for its nutrition; but it does not exhibit in it any thing peculiar.

It is the sensible organic contractility that is the predominant property in this system, all the functions of which rest almost entirely upon this contractility, as all the functions of the preceding muscular system are derived as it were from the animal contractility. We shall now examine more in detail this essential property, with regard to which physiology owes so much to the illustrious Haller. We can consider it in three relations; 1st, in the stimuli; 2d, in the organs; 3d, in the action of the first upon the second.

Of the Sensible Organic Contractility considered in relation to Stimuli.

Stimuli are natural or artificial. The action of the first is continual during life; upon them turn in part the organic phenomena; they place in action the muscles, which without them would be immoveable; they are as it were to these organs what pendulums are to our machines; they give the impulse. The second can hardly have effect until after death, or in our experiments.

Natural Stimuli.

These stimuli are blood for the heart, urine for the bladder, aliments and excrements for the gastric organs. Every organic muscle has a body, which, habitually in contact with it, supports its motions, as every animal muscle habitually in relation with the brain, borrows from it its power of motion. The natural stimuli support the organs at the same degree of mobility while they remain the same. All things being equal on the part of the organs, the pulse does not vary, the digestive periods continue for the same length of time, the intervals between the excretion of urine are equal, whilst the blood, the chyle or the urine exhibit no differences. But as these

substances experience an infinite number of varieties, the organs preserving the same degree of sensibility, have yet frequent changes in their motion.

At the instant chyle enters the blood during digestion, the pulse changes, because the heart is differently irritated. We observe the same phenomenon under different circumstances ; 1st, in re-absorptions in which pus goes into the mass of blood ; 2d, in the injection of different fluids in the veins, injections that were so frequently made in the last age, at the period of experiments upon transfusion, and which I have also had occasion to make with other views which I shall mention ; 3d, in inflammatory diseases in which the blood takes a peculiar character that is yet but little known, and which occasions the formation of the pleuritic buff ; 4th, in various other affections, in which the nature of this fluid is remarkably altered ; 5th, in the passage of the red blood into the system with black blood. I have observed that in putting a curved tube into the carotid of one side and the jugular of the opposite of a large dog, so that one forces blood into the other, the passage of the red blood into the veins is not fatal like that of the black blood into the arteries ; but there is almost always at first an acceleration of the motions of the heart.

The influence of the degeneracy of the fluids in diseases has no doubt been exaggerated ; too frequent a source of morbid derangements has been placed in this portion of the economy. But it cannot be denied, that according to the different alterations that the fluids exhibit, they may be capable of exciting differently the solids that contain them. We know that in the same individual, and with the same mass of aliments, digestion varies from one day to another in the duration of its periods ; that some aliments prolong and others accelerate it ; that some remain very long in the stomach, as it is said, and others as it were only pass through it. Now in all these cases

the organ remains the same, the fluid only varies. According as the kidney secretes urine more or less acrid and consequently more or less irritating, the bladder retains it for a longer or shorter time. Such is oftentimes its stimulating qualities, that the moment it comes into this organ it is involuntarily rejected. Shall I speak of emetics and evacuants by the intestinal canal, the effects of which are so variable? We know that the words drastic, purgative, laxative, &c. indicate the different degrees of the stimulating qualities which certain substances introduced into the alimentary canal exhibit, degrees which are to be considered abstractedly from those of the sensibility of the organs; this in fact can be such, that a laxative may produce greater effects than a drastic purge.

Not only the quality, but also the quantity of the fluids contained in the organic muscles, has an influence upon their contractility. 1st. The word plethora is certainly employed too loosely in medicine; but we cannot doubt that the state which it expresses sometimes exists; now the more blood there is in the heart, the more are its contractions accelerated. 2d. I have many times made transfusion in dogs, whether with a view to that alone, or in researches relative to respiration and circulation. Now I have always observed, that by not opening a vein, to empty the blood as fast as the external jugular receives it (for I always choose this vein for the experiment) by thus producing consequently an artificial plethora, I have, I say, always observed that the motion of the heart was accelerated. I have even seen the eye of a dog become bright and as it were inflamed; in others this phenomenon has not been observed. 3d. We know that in running, in which all the muscles by contracting press out from all sides the venous blood contained in their texture, this which enters the heart in abundance, makes it palpitate powerfully. 4th. There is not doubt but that the quantity of urine and excrements as much and

more than their quality, is for the bladder and the rectum, a cause of involuntary contraction. 5th. We know the serious consequences that arise from giving emetics and cathartics in too large doses. 6th. A glass of tepid water often does not produce vomiting when a pint will bring it on powerfully, &c. &c.

Artificial Stimuli.

The artificial stimuli are in general all the bodies in nature. Such is in fact the essence of organic contractility, that a muscle because it is in contact with a body to which it is not accustomed, instantly contracts. If the muscles are not irritated by the organs that surround them and with which they are in relation, it is because habit has blunted the sensation which arises from this relation. But when these organs change their modifications, when extracted from the body of the animal, they become cold, and are afterwards applied to the organic muscles laid bare, they will make them contract.

Caloric, by its absence which constitutes cold, as by its presence from which arises heat, can equally excite the muscles and in general all the organs. At the instant we open the thorax or the pericardium of a living animal, the heart is agitated with a suddenly increased force; it is because the air acts upon it, and it passes from the temperature of the body to another which is different. All the æriform fluids, light, all fluids, &c. are stimuli of the muscles. If we see the heart emptied of blood, the stomach and intestines deprived of the substances that ordinarily enter them, contract with more or less force when they have been taken out of the body, it is because the surrounding medium, and the substances with which it is charged, contribute to produce this effect; they are then the stimuli of these organs.

In general the artificial stimuli act in different ways; 1st, by their simple contact; 2d, by tearing or cutting

mechanically the fibres; 3d, by tending to combine with them; 4th, there are some of whose mode of action we are completely ignorant; such for example is electricity.

When the stimuli act only by simple contact, the fluids are, all things being equal, more efficacious than the solids, because they stimulate by a greater number of points; as they irritate not only the surfaces of the organ, but penetrate also into the interstices of the fibres. The solids produce an effect in proportion to the extent of their excitement, to the greater or less pressure that they exert, to their density, their softness, &c. They are almost always fluid substances that nature employs for stimuli in the ordinary state.

Tearing is a mode of excitement more active than contact. The heart, the intestines often inert when they are only touched by the scalpel, contract powerfully when the point of it excites them. Cutting produces a less sensible effect than tearing. Cut transversely, the fibres oscillate and are agitated only by the sensible organic contractility, whilst by the contractility of texture they experience an evident retraction.

Chemical excitement is, in the greatest number of cases, the most advantageous; but it is necessary here to distinguish that which belongs to the horny hardening, from that which is the effect of irritability brought into action. 1st. Plunge a frog without skin and alive into a concentrated acid; instantly every thing is disorganized; the reagent acts so strongly, that we can distinguish neither horny hardening nor contractility. 2d. Weaken the acid a little and plunge into it, the inferior extremities only of a frog; in an instant they stiffen by the contraction of the extensors, which overcome the flexors; for in this experiment, this is almost a constant phenomenon; withdraw the animal; its thighs remain immoveable, life has been extinguished in them; the contraction that has come on is a horny hardening, and not a vital phenomenon. A

dead frog plunged into the same liquor experiences the same phenomenon. 3d. Weaken the acid still more; the instant the animal is plunged into it its limbs contract; but relaxation succeeds the contractions; these are alternate motions; it is the irritability that begins to be put into action. Yet if the acid is not very weak, some marks of the horny hardening still remain, and the animal has a stiffness in the motions of the inferior extremities, the evident result of the first degree of this horny hardening. 4th. Finally, if the acid is very weak, it becomes a simple irritant which puts in action the sensible organic contractility, without altering the texture of the fibres; the animal after coming out of the fluid preserves the same power of motion.

These experiments which it would be easy to multiply upon animals with warm blood, but which I have never attempted upon them, evidently show what belongs to the horny hardening, and what is the effect of vital contraction. Yet there is not an exact limit between them, and there is one degree of weakness of the acid in which these two causes of motions are confounded.

There is a mode of excitement to which authors have not paid attention; it may be called negative; it is that of which I spoke just now on the subject of caloric, the privation of which is oftentimes a very active stimulant. In the different experiments that I have had occasion to make, this has frequently struck me. Apply a stimulant to a muscle, it contracts; but at the end of some time the motion ceases, though the contact continues; remove the stimulant, the motion frequently returns in an instant. In general, nothing is more common in the heart, the intestines, &c. than their contractions ceasing under the continued action of a stimulant, and returning instantly upon its absence. I confess that this phenomenon is not as invariable and constant as that of the contraction produced by the application of the stimulus which succeeds a state

of non-excitement; but this happens very often. We might say that the organic sensibility is in this case like the animal; that every new state affects it, whether it be positive or negative. The passage from non-excitement to excitement is more lively; but the opposite passage is not less when it is sudden. Moreover this manner of describing the sensible organic contractility in exercise, deserves some further experiments.

Of the Sensible Organic Contractility considered in relation to the Organs.

The sensible organic contractility, considered in the organ in which it has its seat, exhibits numerous varieties which are relative; 1st, to the diversity of texture; 2d, to age; 3d, to sex; 4th, to temperament, &c.

First Variety. Diversity of the Muscular Texture.

The animal contractility is everywhere the same in the voluntary muscles, because their organization is uniform. All things being equal as to the number and length of the fibres, the phenomena of contraction are exactly the same everywhere; here, on the contrary, the varieties of texture inevitably produce varieties in the vital properties.

Each involuntary muscle is at first especially in relation with the fluid which ordinarily acts as its stimulus. The blood alone can regularly support the motions of the heart. Let this fluid be altered in any manner, the contractions become irregular. All foreign substances forced into the veins produce this phenomenon. The urine, which supports with harmony the motions of the bladder, would disturb those of the heart, if it circulated in its cavities. The blood, more soft in appearance than the urine, can agitate convulsively the bladder, if it happens to be in it. I took care with Desault of a patient affected for a long time with retention of urine, and whom he had cut for a very large stone. After the operation, the urine

remained stagnant in the bladder as long as it was alone, but when a little blood entered this organ, it contracted involuntarily and the bloody urine was evacuated. The excrements, which could continue for a long time in the rectum without making it contract, would make the stomach heave in an instant, &c. All these phenomena are to be referred to varieties of sensibility of the mucous membranes, varieties which we shall notice again. They prove evidently that each muscle has a degree of organic contractility which is peculiar to it, and that this or that fluid of the economy can exclusively, in a natural state, put it in exercise in a regular manner.

Foreign fluids exhibit the same result; the emetic which makes the stomach contract, is injected with impunity into the bladder; purgatives do not produce vomiting, &c. This relation of foreign fluids with the sensible organic contractility takes place, whether, as in the preceding case, these fluids are applied to the mucous surfaces corresponding to the muscles, or whether they come to the muscles by the circulation, as the experiments have proved which were made in the last age upon the introduction of medicinal substances into the veins; experiments of which Haller has collected a great number of results. We have seen in these experiments, the circulation present to all the organs sometimes an emetic, and the stomach alone contracts; sometimes a purgative, and the intestines only enter into action, &c. Taken in by cutaneous absorption, medicinal substances occasion the same phenomenon. Applied by friction, purgatives, emetics, &c. do not make all the organic muscles contract, though the circulation presents them to all, but only those with which their sensibility is in relation.

In the various affections of which they are the seat, we see the organic muscles having each a peculiar mode of irritation answer to each stimulus, and remaining deaf, if we may so say, to the voice of the others.

Second Variety. Age.

Age modifies wonderfully the sensible organic contractility. In infancy it is very evident; the muscles answer with extreme ease to the stimuli; the bladder retains the urine with difficulty; children void it in sleep involuntarily; the heart contracts with a rapidity of which the pulse is the measure; all the digestive phenomena are more prompt; hence there is less interval between the returns of hunger. It is a phenomenon analogous to that of the voluntary muscles, in which the rapidity of the motions is found, in the first age, connected with their small degree of force.

After infancy, the susceptibility of the muscles to answer to their stimuli, is constantly diminishing; thus all the great phenomena of organic life are continually becoming slower. The number of pulsations, the duration of digestion, the longer continuance of the urine, &c. are the thermometer of this slowness.

In old age the whole is weakened; the action of the organic muscles gradually diminishes. Those of the bladder and rectum are the most exposed to lose their contractile faculty; hence the retention of urine, which is a frequent companion of old age; hence also the accumulation of fecal matters above the anus, a disease almost as common as the first at this age of life, though it has received less attention from practitioners. Rich people and those accustomed to the luxury of the table are especially subject to it. I have seen much of it, as much even as of retention of urine, in the last year of the practice of Desault. The intestines and the stomach languish more slowly in their functions. It is the heart which resists the most; it is the ultimum moriens, as it has been the first in exercise; the duration of its pulsations measures exactly the duration of organic life.

Third Variety. Temperament.

Temperament modifies in a remarkable manner organic contractility. We know that in some the pulsations are more frequent, the digestive and urinary phenomena more rapid; that in others, every thing is marked by more slowness in organic life; now these varieties have evidently their primitive source in the varieties of the contractility of the heart, the stomach, the intestines, &c. which have under this relation a great influence in the difference of the temperaments. With respect to this there are two essential observations to be made; 1st. The varieties of force of the organic muscles do not always coincide with those of the muscles of animal life. Thus we see an individual with feebly developed exterior forms, with an evident weakness of the muscles of the extremities, whilst the activity of digestion, of the urinary evacuations, &c. announces the greatest energy in the sensible organic contractility. I would remark with regard to this, that the heart is more frequently in relation of force with the external muscles than the stomach, the intestines and the bladder. A full pulse, well developed, is usually found with an athletic constitution; whilst often this constitution is united in the same subject to a feeble gastric system, and especially the force of this gastric system is frequently connected with external weakness. This fact, which the different temperaments demonstrate to us in man, is evident in the series of animals. Those who, like the carnivorous ones, have a very powerful animal muscular system, have the parietes of the gastric cavities like membranes. These parietes are strong in the herbivorous classes; they become very conspicuous in the gallinaceous. In general, mastication over which the animal contractility always presides, is in animals in an inverse ratio of the force of trituration of the stomach, over which the sensible organic contractility presides.

2d. The varieties of this property, relative to temperaments, exhibit another phenomenon almost always foreign to the animal muscular system. In fact in this the varieties are always general; we are able by exercise to strengthen this or that muscular region; but the differences of forces which are natural, always influence the whole system. The arms and the legs, the thorax and the abdomen are uniformly contractile in the different divisions of the muscles that belong to them. On the contrary, it is rare to see this uniformity in the involuntary muscles. One almost always predominates over the others; sometimes it is the heart, sometimes the stomach and sometimes the bladder. The gastric viscera even are frequently not all at the same level as to force. The stomach is feeble when the intestines preserve their ordinary action; and reciprocally the intestines too contractile expel immediately fecal matters and thus produce a diarrhœa, though the stomach may perform its functions well. This essential difference in the two muscular systems arises from the circumstance that the contractility of one depends upon a common centre, the brain; whilst that of the other on the contrary has its principle insulated in each organ in which it exists.

Fourth Variety. Sex.

Women in general resemble children in the phenomena of sensible organic contractility. The weakness of the motions coincides with their greater rapidity in this sex, all whose internal muscles, like the external, are more delicate and less strongly developed than in man. It might be said that the contractile power of the womb has been formed at the expense of the forces of all the other organs. In experiments, females give results much less decided and always less durable than males. The motions of the heart, the stomach, the intestines, &c. cease sooner;

these motions are less; it requires stronger stimuli to produce them, &c.

Fifth Variety. Season and Climate.

In winter and in cold climates, in which the cutaneous organ contracted, and having as it were the horny hardness from the impression of the surrounding air, has but a feeble action, all the internal functions more active, require more energy in the forces that preside over them; all the digestive, urinary and circulatory phenomena are more evident. I do not know that there has yet been made any comparative experiments upon irritability in the different seasons; but I am persuaded that they would give different results.

Sensible Organic Contractility considered in relation to the Action of Stimuli upon the Organs.

We have just described separately the stimulant and the organ stimulated; each being separate there is no effect upon the sensible organic contractility; from their union alone results the exercise of this property. What happens in this union? We know not. To wish to know it, would be to wish to know how one body attracts another, how an acid combines with an alkali, &c. In attraction, affinity and irritability, we can only trace the phenomena to the action of bodies upon each other. This action is the utmost limit of our researches.

But that which ought not to escape us here is, that in this last property, the action is never immediate. There is always between the stimulus and the organ something intermediate which receives the irritation; this intermediate organ is a delicate membrane and continuous with that of the arteries for the heart; it is a mucous surface for the gastric viscera and the bladder. This intermediate organ is more susceptible of receiving excitement than the muscle itself. I have uniformly observed that by

irritating the internal surface of the heart, its contractions are greater, than by laying its texture bare externally by removing its serous covering and afterwards stimulating it. The same is true with regard to the organic muscles of the abdomen.

Is there between the intermediate organ excited and the organ which contracts, any nervous communications that transmit the impression? I think not, the cellular texture is sufficient. In fact the serous surfaces and the organic muscles have only this texture as a means of union. The life of the first is in no way connected with that of the others, since they often leave them as we shall see, and yet they can transmit excitement to them. The pericardium and the peritoneum, irritated in their portion corresponding with the organ that we wish to move, produce a contraction in it. This fact is known to all those who have made the least experiment; it is almost always in this way that we stimulate the heart, the stomach, the intestines, the bladder, &c. By carrying the stimulus over the serous surface but very lightly, and so as not to communicate the motion to the fleshy fibres, we obtain a result. Yet simple contact is not sufficient to transmit the irritation; for example, by leaving the external layer of the pericardium applied to the heart and afterwards irritating it, the organ remains immoveable. If we separate the peritoneum from above the bladder, so as to break all the cellular adhesions, and afterwards reapply and stimulate it, the same immobility is observed.

When the intermediate organ that receives the excitement is diseased, the contractility is uniformly altered. The same stimulus produces slow or rapid contractions, according as the affection raises or diminishes the sensibility of this intermediate organ. A slight inflammation of the exterior of the bladder produces a kind of incontinence of urine; that of the intestines occasions diarrhœa, &c. &c. On the contrary, old catarrhs of the blad-

der, the affections in which weakness of the mucous surface of this organ predominates, are the frequent causes of retention.

I would observe that the existence of this intermediate organ is a remarkable difference between the sensible organic contractility and the insensible, for this organ does not exist in this last, in which the same system receives the impression and reacts upon the body that has produced it; for example, in the glandular, serous, cutaneous systems, &c. the fluid which enters them for secretion or exhalation produces in them the sensation, which is instantly followed by the reaction. In the sensible contractility on the contrary, one system feels and another is moved. This kind of mobility is less removed from that of animal life, in which the organs of the senses and those of the motion being wholly different, are very distant from each other.

Sensible Organic Contractility considered in relation to its duration after Death.

This duration is longer than that of the animal contractility. When the spinal marrow is irritated, the external muscles remain immoveable, whilst the internal ones are still in activity. There have been so many examples related of this duration, Haller has multiplied experiments so much upon this point, that there is no occasion for me to give proofs here of a fact of which no one can any longer doubt. To this duration are owing the evacuations of fecal matter and urine which often take place an instant after death; the vomitings that are observed in some subjects, if not in as evident a manner as during life, at least sufficient to raise the aliments into the mouth of the dead body, which is often completely filled with them, as I have frequently seen.

It is necessary, in relation to this duration, as in relation to that of the animal contractility, to distinguish two

species of death; 1st, those that take place suddenly; 2d, those which are the consequence of long disease.

In every sudden death, produced either by a violent lesion of the brain, as in apoplexy, concussion, compression, effusion, &c. or by an affection of the heart, as in syncope, a wound, or a ruptured aneurism; or by a cessation of the action of the lungs, as in asphyxia from deleterious gases, a vacuum, submersion, &c. the duration of contractility is very evident; general death comes on first, then the organs die partially; each vital force is afterwards successively extinguished.

In every kind of death slowly produced, in all those especially which are preceded by a disease of weakness, it is the partial death of each organ that first takes place; each vital force is weakened and extinguished, gradually, before the cessation of them as a whole, which constitutes general death, comes on; when this death takes place, none of the lives peculiar to each organ remains, whilst most of these lives continue for a longer or shorter time after sudden death.

We cannot make these experiments upon dead bodies which we rarely have in the hospitals till fifteen hours or more after death; but by killing dogs by hunger, which, when long continued, becomes a real disease that lasts in these animals eight, ten and even twelve days, I have seen the contractility entirely extinguished at the moment of death. Dogs have been often brought to me affected with different diseases, especially three years since when there was a kind of epidemic among these animals; now by opening them at the instant of death, by killing them even some time before and thus producing a sudden death wholly different from that which happens in the sound state in which all the parts are uninjured in their functions and consequently in their vital forces, I have always seen a constant absence of contractility, or at least so greatly weakened that it appeared to be nothing.

Many physiologists have spoken of a general convulsion which comes on in the organic muscles at the instant of death, of a rising of the heart, the stomach, the intestines, &c. This excess of action is sometimes real in sudden deaths, in those especially that we produce for our experiments; it is very rare in deaths preceded by a long disease in which the patient is extinguished, as it were, insensibly, and passes gradually from life to death. It is a fault common to almost all authors, to generalize too much the facts observed under certain circumstances. Many false consequences are the results of it.

Sympathies.

No organ receives more easily the influence of others, than the organic muscles; all however are not equally susceptible of it. The heart occupies the first rank in this respect; then comes the stomach, then the intestines, and finally the bladder. It is in this order that we shall now examine this influence.

It is a remarkable phenomenon, that every kind of affection in any degree strong, arising in the economy, alters immediately the motions of the heart. The least wound, oftentimes the slightest pain are sufficient to produce derangements in it; now these derangements are of two kinds; sometimes its action is arrested for a moment; hence syncopes, a mode of derangement which happens especially in violent and sudden pains. The vulgar expression which is employed in these cases, viz. "my heart is failing," is perfectly true. Sometimes, and this is the most common case, this action is accelerated; hence the febrile motions so frequent in all the local affections, motions purely sympathetic and which cease when the affection disappears. In many local inflammations, the evil is too circumscribed to admit an obstacle to the course of the blood, an obstacle, which according to Boerhaave, forces the heart to redouble its action to surmount it; besides

when there is no swelling, but only pain in the part, and the febrile motion comes on, it is there clearly a sympathetic phenomenon. The increase of the action of the heart may depend no doubt upon a foreign substance, which, mixed with the blood, alters and renders it more irritating; it may be owing to an affection of the substance of the organ which disposes it to be more irritable; but it is certainly very often sympathetic, and depends upon that unknown relation which connects all our organs, upon that consensus which links together all their actions, and places them in reciprocal dependance.

I shall say as much of the stomach; though its sympathetic reaction may not be altogether as frequent as that of the heart, yet it becomes very evident under many circumstances. Most local affections, especially inflammations are accompanied with sympathetic vomitings. Various fevers have in their commencement similar vomitings. It is in the hospitals especially that we frequently observe these phenomena. Many physicians have not considered these vomitings as merely sympathetic, but as the index of a bilious affection, founded on this, that bile is then almost always thrown up. But in all the animals that I have opened, I have almost always seen the stomach when empty containing a certain quantity of this fluid which had flowed back from the duodenum; other authors have also made similar observations; so that it appears that in the state of vacuity, the existence of bile in the stomach is a natural phenomenon. Hence it is not astonishing, that in the commencement of diseases, and even in their course, the stomach being sympathetically excited and thus becoming the seat of vomiting, more or less of this fluid should be thrown up. It would be brought up even in health if vomiting is then excited by an emetic; this is what sometimes happens in the morning when the stomach is empty, if any cause foreign to an affection of the liver, as the sight of a dis-

gusting object, produces vomiting; the bile then comes out like every thing else that is contained in the stomach. I do not say that oftentimes the liver being sympathetically excited in the commencement of diseases, does not furnish more bile, that this superabundant bile flowing into the s omach, does not make this viscus contract; but certainly this is not most commonly the case; we vomit bile as we discharge it by the anus, because it is found in the stomach and intestines, and not because it is superabundant. If vomiting was a natural function, the bilious evacuations in this way would be as natural as the greenish tinge of the excrements, which is always found in a state of health. We see then, from this, that the bilious vomitings are, in many cases, purely accessory, and that the essential phenomenon is the sympathetic contraction of the stomach.

In the case of which I have just spoken there is no gastric difficulty; the sympathetic alteration of the stomach only extends to the fleshy fibres. But most frequently this gastric difficulty appears at the beginning of diseases in which there is local affection; sand-like substances are vomited up; it is because then the organ essentially affected, the lungs for example, if it is in a peripneumony, has acted sympathetically not only on the fleshy fibres, but also upon the mucous membrane. This excited increases its secretion; hence these sand-like substances, which are nothing but the mucous juices mixed with the gastric fluid and with the bile; now the presence of these substances is often sufficient to make the stomach contract, and produce vomiting which expels them.

From this it is evident that there can be sympathetic vomitings without gastric difficulty, and sympathetic gastric difficulty with a vomiting immediately produced. In the first case the fleshy fibres feel the sympathetic influence of the affected organ; in the second it is the mucous membrane. But how, when the lungs, the pleura, the

skin, &c. being affected, does the stomach come into action? I have said that the word sympathy was only a veil for our ignorance in respect to the relations of the organs to each other. Vomitings produced by erysipelas, phlegmon, pleurisy, peripneumony, &c. are then most often an effect exactly analogous to the increase of the action of the heart, which produces fever. They resemble the cerebral derangement from which arises delirium, a derangement which is much more rare, &c. All these phenomena indicate that the other organs feel by reaction the state of that which is affected, &c. Physicians who have not viewed all these phenomena in a great and general manner, have confined their treatment to too narrow bounds. Much attention was formerly paid to the sympathetic derangement of the heart, and bleeding was much practised in the beginning of diseases; for some years past much regard has been had to the sympathetic derangement of the stomach, and emetics are frequently given; perhaps before long, more attention will be given to the weights of the head, pains in that part, watchfulness, drowsiness, &c. which are very common sympathetic symptoms, and the treatment will be directed to the brain. In these varieties judicious physicians will regard all these phenomena in a general manner; they will see in all a proof of that general agreement which disposes together all the functions, which connects all and thus connects their derangements; they will see each organ rise up, as it were against the evil which is introduced into the economy, and each react in its own way; they will see these reactions producing effects wholly different, according to the organ reacting, fever arising from the reaction of the heart, delirium, drowsiness, watchfulness, convulsions, &c. from that of the brain, vomiting from that of the stomach, diarrhoea from that of the intestines, gastric and intestinal derangements, foulness of the tongue from those of the mucous membranes, overflowings of

bile from that of the liver, &c. Thus in a machine in which the whole is united and connected together, if one part is deranged all the others are so also. We should laugh at the mechanist who attempted to mend but one of these pieces, and neglected to repair the local derangement from which all those arose which the machine exhibits. Let us not laugh at the physician who attacks only a single symptom, without combating the disease, of which he oftentimes knows not the principle, though he knows that this principle exists; but let us laugh at him, if he attaches to his treatment an importance which is nothing compared with that of the disease.

The intestines next to the stomach are the most often sympathetically affected in diseases. The bladder is the organic muscle that is the last to feel the influences that go from the diseased organ; this sometimes however happens. In fevers, we know that retentions of urine from sympathetic and temporary paralysis, are not very rare; incontinence of urine is less often seen.

Character of the Vital Properties.

We see from what has been said, that the vital properties are very active in the organic muscles, especially as it respects contractility. These muscles are really during life, in constant action; they receive with great ease the influence of other organs. Their vital properties are altered with the greatest promptness, especially that which I have just pointed out; for the insensible contractility is rarely altered in them, because it does not perform an essential part. Observe in fact that the morbid derangements of an organ affect always the predominant vital force of that organ. Animal contractility is frequently altered in the preceding system; in this it is the sensible organic contractility. On the contrary, the insensible being very small, the phenomena over which it presides remain always nearly the same; nutrition is always uni-

form; lesions of the muscular texture are rare; when they take place, it is rather by communication, as in cancers of the stomach, in which the disease begins upon the mucous surface, and in which the fleshy fibres are only consequently affected. The heart and the womb are the muscles that are the most subject to these morbid alterations; yet in the first they belong oftener to the internal membrane than to the fleshy fibres themselves. On the contrary in the systems in which the sensible organic contractility is incessantly in action, as in the cutaneous, the serous, &c. in which it presides over nutrition and exhalation; in the glandular, the mucous, &c. in which it produces secretion and nutrition, it is this which is especially altered. From these derangements arise alterations of texture, organic diseases properly called, which are as common in these systems, as they are rare in those in which the insensible contractility, is so very obscure, as to be only at the degree necessary for nutrition.

It is to this that must be referred the infrequency of acute inflammations of this system. As this affection is frequent in the cutaneous, the serous, the mucous systems, &c. so this system, whose functions require but little insensible organic contractility, presents it rarely. Those who open many dead bodies know, that the texture of the heart is hardly ever found inflamed. Nothing is more common than phlegmasia of the external or serous membrane, and of the internal or mucous membrane of the stomach, the intestines, &c.; but nothing is more obscure and less frequently seen than that of their fleshy tunic. In rheumatism, there is sometimes when the pains cease around the joints, violent cholics, spasmodic vomitings even, indices perhaps of an acute affection of the fibres of the stomach or intestines; but we never find marks of these affections; we do not see the muscular texture exhibiting the bright red of the inflamed mucous,

cutaneous and serous organs; or at least I have never observed it.

Physicians have not paid sufficient attention to the difference of inflammations according to the difference of systems; but especially they have not sufficiently observed that this difference accords perfectly with that of the insensible organic contractility; that where this vital force is most characterized, inflammations have the greatest tendency to take place, because it is this which presides over their formation; because these affections suppose its increase; as convulsions suppose the increase of animal contractility, as vomitings, accelerated pulsations of the heart, suppose that of organic contractility, &c. I cannot repeat it too much, that the most frequent diseases in each system, put always in action, raise or diminish the predominant vital force in that system. It is a new pathological view, that may be fruitful in results.

ARTICLE FOURTH.

PHENOMENA OF THE ACTION OF THE MUSCULAR SYSTEM OF ORGANIC LIFE.

These phenomena are, as in the preceding system, relative to the state of contraction or to that of relaxation.

I. *Force of the Contractions.*

It is never capable of being raised to the point which the force of the muscles of animal life sometimes attains. Between the strongest and the weakest pulse, between

the feeble jet which precedes some retentions of urine, and the jet of the most vigorous man, there is much less difference than between the langour of the voluntary muscles of some women and the power of those of a maniac, or a man in anger. The heart and the deltoid muscle are nearly equal in respect to their fleshy mass; now what would become of the circulation, if the first sometimes sent the blood with the force which the second uses to raise the superior extremity? A fit of anger, mania, &c. is sufficient to produce aneurisms. On the other hand the organic muscles are not affected with those prostrations of forces so common in the others; paralysis is foreign to them, because they are not within the cerebral influence. There is something which answers to convulsions; it is the irregular agitations which produce so many varieties in the pulse of acute fevers, agitations which must be distinguished from those produced by an organic defect of the heart; but these agitations are wholly different from spasms of the voluntary muscles; there is even no analogy.

There is not in the force of the contraction of the muscles of which we are treating, the waste which is so remarkable in that of the other muscles; the effort is nearly proportionable to the acting cause, and the distinction of this force into absolute and effective, cannot be applied here; only there is required more or less contractile energy, according as the body to be expelled from a hollow muscle, is solid or fluid. Hence why the great intestines are provided with longitudinal fibres more characterized than those of the small intestines; why the rectum especially, in which the excrements have their greatest degree of solidity, exhibits these fibres in a more evident manner than the colon or the cæcum, though under a different form; why in diarrhoeas the weakest contraction is sufficient to evacuate the intestines, whilst the sensible organic contractility of the rectum being in-

sufficient to void very solid excrements, it is necessary that the abdominal muscle should aid the expulsion ; why when a hard body is introduced into the stomach, and the gastric juices do not soften it, it remains there a long time before being expelled, and produces an inconvenient weight, &c. &c. We know with what rapidity the passage of liquids takes place from the stomach to the intestines, and how long on the contrary solid aliments remain in the first.

The force of the organic muscles is incomparably greater in the phenomena of life than in our experiments. Once laid bare, the heart communicates only feeble motions, and most often irregular ones. There is no proportion between the force necessary to produce the jet, sometimes from seven to eight feet, which the blood exhibits coming from the open carotid of a dog, and the force of the contractions which the strongest stimuli produce when applied to the heart extracted from the body. Nothing equals in our experiments the force of contraction necessary for vomiting, &c. &c.

Numerous calculations have been made upon the force of contraction, in the organic muscles as in the preceding, and there has been the same variety of results. Can we in fact calculate the degrees of a phenomenon which a thousand causes make vary every instant, not only in different individuals, but even in the same, which sleep, digestion, exercise, rest, tranquillity of mind, violence of the passions, day, night, every thing in a word, incessantly modifies ? I do not know that we digest twice in exactly the same period, if the urine twice remains the same length of time in the bladder before being discharged, if its jet is twice exactly equal, &c.

The force of the organic muscles often remains in its ordinary degree, or is even increased ; whilst a general weakness possesses the others. The force of the pulse, vomiting, diarrhoea, &c. coinciding with a general pros-

tration of the muscles of animal life, are not rare phenomena in diseases.

II. *Quickness of the Contractions.*

It varies singularly; very rapid in experiments, when death is recent and the stimuli are very strong, the contractions are in general slower in the natural state; we might say that it is in the inverse ratio of the force; often at the instant we open the pericardium, the heart moves with a rapidity which the eye can hardly follow, especially if we inject an irritating fluid into this serous sac, a little before laying the organ bare. The contractions increase much in quickness in certain diseases; those of the heart, for example, then acquire in the adult a rapidity often much greater than they have in the first age; this rapidity is also in this case entirely distinct from the force of its contractions; it is rare even that these two things are found united at the highest point. In general when the force of the heart is increased, there is a little more quickness; but there is very often a dimunition of force with an increase of quickness, or the force remains the same, the quickness being much increased.

We have seen that the voluntary muscles have in general a degree of quickness beyond which they cannot go, and that this quickness belongs to the original constitution. Is not the same phenomenon observed here? Often in two fevers whose symptoms are the same, whose degree of intensity seems to be exactly uniform, the pulse is infinitely more frequent in one individual than in the other. This does not always denote a difference in the disease, but in the primitive constitution, an aptitude of one of the two hearts to contract much quicker under the same stimulant. Who does not know that in experiments, the contractile rapidity is infinitely variable under the influence of the same causes?

Each organic muscle has its degree of quickness; the heart, the stomach, the intestines, the bladder, &c. differ remarkably in this respect.

III. *Duration of the Contractions.*

The heart never remains in permanent contraction, as often happens in the voluntary muscles. Though hunger seems to prove the contrary in the stomach and the intestines, yet this phenomenon is not contradictory; in fact, the permanent contraction of the empty gastric viscera is the result of the contractility of texture. Whenever the sensible organic contractility is in action, there is alternate contraction and dilatation; this alternation even characterizes essentially this last property, and distinguishes it from the animal contractility and from that of texture, in which the state of contraction is often permanent.

IV. *State of the Muscle in Contraction.*

All the phenomena described for the voluntary muscles, are almost applicable to these, such as the hardening, increase in thickness, diminution in length, expression of the blood, &c. &c. But there are some differences between the heart and the gastric muscles, in respect to the mode of contraction. In fact we see very sensibly in the first, 1st, contractions of the whole analogous to those of the voluntary muscles, contractions which take place in the state of health, which produce the projection of the blood, and which are easily made in experiments when the animals are still living; 2d, numerous oscillations which seize upon the fibres, which agitate the whole of them without producing any sensible effect, without contracting the cavity, without projecting the blood for example. These oscillations are observed at the instant of death, when the heart is ceasing to be contractile; we may then irritate it in vain, there are no more contrac-

tions of it as a whole; though there is a general and very evident vibration of its fibres, yet its cavity is not contracted; the blood stagnates in it. The heart perfectly resembles under this double relation the voluntary muscles; it is agitated as we see these muscles in the shuddering, that is called horripilatio, as we see it also in certain sub-cutaneous muscles in some individuals. I have already, for example, seen many persons affected with an habitual trembling of a portion of the solæus, a trembling very evident to the eye through the skin, and which had nothing in common with the contraction necessary to the extension of the foot.

The involuntary muscles of the abdomen never exhibit this double mode of contraction. Instead of the quick and sudden motions of the whole of the muscle, we see but a slow contraction in it, often but slightly apparent; it is a kind of creeping; there is not even to speak properly a contraction of the whole, like that of the heart in which all the fibres of an auricle or ventricle are moved at the same time; here each fleshy surface appears to act successively. Placed at the origin of the great vessels, the bladder and the stomach would be incapable of communicating to the blood those motions by jerks, which the jet of an artery exhibits at each contraction. On the other hand, at the instant the motion ends in the stomach, the intestines and the bladder, we never see in them those oscillations, those vibrations which are almost constant in the heart and the voluntary muscles, and which we can even create in them at will.

V. *Motions imparted by the Organic Muscles.*

There are hardly ever simple motions in these muscles; the different interlacing of their fleshy surface allows them to act almost always in three or four different directions upon the substances they contain. We can say nothing

general upon those motions which compose the diastole of the heart, the peristaltic motion of the alimentary canal, the contraction of the bladder, &c. Each muscle has its mechanism which belongs to the physiological history of the function to which it contributes.

VI. *Phenomena of the Relaxation of the Organic Muscles.*

In the relaxation of the organic muscles, phenomena in general take place that are opposite to the preceding. It is then useless to enumerate them; but there is a question here that should be examined, that of knowing the nature of that state which succeeds contraction and alternates with it.

In the muscles of animal life, when the contraction ceases, the muscle does not in general go back itself to the state it was in antecedent to the contraction, but it is drawn back to it by its antagonist; for example, when the biceps is contracted to bend the fore-arm and its contraction ceases, it becomes passive; the triceps putting itself then in motion, extends it and draws it back to its natural position, by acting at first on the bones which communicate the motion to this muscle. Each muscular power of animal life finds then in that which is opposed to it a cause of return to the state it had left in order to contract. It is not so in organic life; its muscles, which are all hollow, have no antagonists. We have considered as such to a certain extent, the substances contained in the hollow muscles, substances which oppose the effect of contraction; but incapable most commonly of reacting after having been compressed, on account of their want of elasticity, these substances cannot perform the same offices as real antagonists.

Most physiologists have admitted as a cause of dilatation, the entrance of new substances, which replace, in the muscular cavities, those expelled by contraction; thus

the entrance of new blood into the heart, aliments into the different portions of the alimentary canal, has been considered as proper to dilate these organs; so that according to this opinion the muscles would be purely passive when they enlarged. But the following considerations, many of which some authors, Grimaud in particular, have already stated, do not permit us to consider in this way the dilatation of the organic muscles, that of the heart in particular.

1st. When we lay bare a hollow muscle, the heart, the stomach, or the intestines, and empty it entirely of the substances that it contains, it contracts and dilates alternately as when it is full, if we apply an external stimulant to it. 2d. If we empty by punctures all the great vessels which go to the heart, or come from it, so as to evacuate it entirely, its alternate dilatations and contractions continue for some time. 3d. In order to judge comparatively of the degree of force of the contraction and the dilatation, we can extract two hearts nearly equal in size from two living animals; place immediately the fingers of one hand into the auricles or the ventricles of the first, and grasp with the other hand the exterior of the second; you will feel that one makes as great an effort in dilating as the other does in contracting. This fact already observed by Pechlin, is so much the more remarkable, as the effort of dilatation is often greater than that of contraction. I have even observed, in repeating this experiment, that whatever effort we make with the hand, we cannot prevent the organ from dilating. 4th. The alternate extension and contraction, from which arises the vermicular motion of the intestines, is seen during hunger when we open the abdomen of an animal. 5th. The hardness of the organic muscular texture is as evident during dilatation as during vacuity. 6th. I have many times observed that at the instant in which I irritated the heart with the point of a scalpel, that a dilatation was the first consequence o

it, and that contraction was only consequent to it. It happens in general more often that contraction begins the motions in our experiments; but certainly, the muscle being at rest, it is frequently a dilatation that first manifests itself.

It appears then very probable that the dilatation of the organic muscles is a phenomenon as vital as their contraction; that these two states are united in a necessary manner; that both of them compose muscular motion, of which contraction is but one part. Who knows even if each may not be disturbed separately, if to a regular contraction may not succeed an irregular dilatation and vice versa? Who knows if certain alterations in the pulse do not belong to injuries of dilatation and others to those of contraction? I am far from being certain; for in medicine we must rest our belief on certainty and not on presumption; but we can make this point an object of research.

It appears that sometimes the voluntary muscles are also the seat of a true active dilatation. 1st. A muscle, laid bare and extracted from the body, contracts and afterwards dilates, without being drawn to this state of dilatation by any cause. 2d. In an amputation, we often see in the stump the end of the divided fibres alternately lengthen and contract; a double motion both of which appears to be equally vital. 3d. In many kinds of convulsions in which the extremities stiffen, in those, for example, which accompany most hysterical fits, it appears that there is a very evident active dilatation; by placing in fact the hand upon the muscles which should then be relaxed, from the disposition of the parts, we perceive a hardness as great as in feeling of the contracted muscles.

There are many researches to be made upon this mode of dilatation of our parts, a mode which undoubtedly is not exclusively confined to the muscular system, but which appears to belong also to the iris, to the spongy

texture of the corpora cavernosa, to the nipples, &c. All these organs move by dilating very evidently; contraction succeeds in them expansion, as in the common muscles relaxation does contraction. Expansion is the principal phenomenon. Perhaps also, as some modern authors have thought, the sudden swellings of the cellular texture, which accompany contusions, bruises, &c. are the result of this mode of motion.

ARTICLE FIFTH.

DEVELOPMENT OF THE MUSCULAR SYSTEM OF ORGANIC LIFE.

The organic muscular system is wholly the reverse of the preceding, as it respects development. This is but slightly characterized in the early ages, whereas the growth of the other is precocious. Let us follow it in all the ages.

I. *State of the Organic Muscular System in the Fœtus.*

In the first days after conception, the heart is formed; it is the first point of motion, a punctum saliens, as it has been called. The researches of different authors, of Haller in particular, have rendered clear the successive progress of its increase in the early periods. Rather late in their formation, the muscles of the interior of the abdomen are yet developed before those that form the parietes of this

cavity. It is the size of the intestines, the stomach, the bladder, &c. almost as much as that of the liver, which gives to the cavity in which these viscera are found, the remarkable capacity that it then exhibits.

Nearly uniform at this age, as it respects the proportion of their size, all the organic muscles are not as much so in regard to that of their texture. The heart is evidently firmer and more dense than all the others; its texture is very distinct. The fibres of the stomach, intestines and bladder are soft and loose and resemble exactly those of the muscles of animal life; but little blood goes to them in proportion to what they are afterwards to receive. The fibres of the heart, on the contrary, dense and compact, have a power of action in proportion to what they are afterwards to have. Their redness is as distinct; as much blood penetrates and consequently nourishes them. This redness of the heart, analogous in the adult to that of the voluntary muscles, forms at this period a contrast with the remarkable paleness of these muscles. Besides it has, as in all the other parts where it exists, a deep tinge, owing to the kind of blood that produces it.

We easily see the reason of the quantity of blood that penetrates the heart, as this organ then very active in its motions, has need of much force, whilst the others, almost immoveable, require but little.

Yet the sensible organic contractility of the heart in the fœtus and in the first age has been exaggerated, undoubtedly on account of the extreme rapidity that the circulation then exhibits. This rapidity depends as much on the activity of the tonic forces of the general capillary system, as on that of the heart; for the blood, when it has arrived in the capillary system, is wholly beyond the influence of the heart, as we have seen; the stay that it makes there is wholly dependant upon the forces of the system itself; now these forces, at that time very active,

accelerate the course of the blood, and send it into the venous system, from which it goes to the heart. If the excitability of this were double and even treble, and the blood entered it but slowly, it would be unable to support a rapid and at the same time continuous pulse. Haller was drawn to this opinion by believing that the heart was the only agent of impulse of the blood circulating even in the small vessels. Besides, there is no doubt that the sensible organic contractility of the heart is less easily put into action by experiments in the fœtus, and that it is also much less durable. Then the strongest stimuli have less effect upon it an instant after death, than those of less power exhibit upon the heart of an animal that has been born. I have many times established this fact upon fœtuses of guinea-pigs. Compared with that of the voluntary muscles, the mobility of the heart is undoubtedly remarkable in the fœtus; but compared to what it will be after birth, it is but slight.

It is precisely the same with the contractility of the stomach, the bladder and the intestines; most commonly we can produce no motion in these muscles by stimuli. Mr. Léveillé has already made these important observations; he has also remarked that the urine remained in the bladder, and the meconium in the great intestines, without producing a contraction sufficient to expel them. I do not think however that there could be during life a complete immobility of the gastric viscera, and for this reason; most commonly the meconium is only met with in the great intestines; it must have been formed in them then, if there was complete immobility of the gastric muscles; now it is much more probable that it is the residuum of the bile, of all the mucous juices, &c.; that consequently it has been pushed successively by a slow action from the superior part towards the inferior of the alimentary canal.

The softness of the organic muscles renders their extensibility of texture very great at this period. I would

observe however that the hearts of dead fœtuses do not exhibit those numberless varieties of size which those of adults do in the right side, according to the different kinds of death.

II. *State of the Organic Muscular System during Growth.*

The first days of existence are marked by an internal motion as quick in manifesting itself as the external of which we have spoken. The sucking of the milk, the evacuation of the urine and meconium, &c. are indices of this general internal motion, of this agitation almost sudden of all the involuntary muscles.

It is not the brain which, entering into action at birth, produces the contraction of these muscles, since as we have said they are not under its government; it appears to depend, 1st, on the sympathetic influence exerted upon their system, by the cutaneous organ, which is irritated by the new medium; 2d, on the excitement made upon the beginning of all the mucous surfaces, and upon the whole of that of the lungs, an excitement which afterwards reacts upon these muscles; 3d, on that produced by fluids introduced into the stomach; 4th, on the sudden entrance of the red blood into all these muscles, till then penetrated like the others with black; this cause is essential; irritability appears to be in part dependant on it, or at least to borrow from it a remarkable increase of force; 5th, the excretion of the meconium and the urine is also powerfully assisted by the abdominal muscles, which then enter into activity with the whole system to which they belong.

The general internal motion which takes place in the first moments of existence, and which is produced by the suddenly increased activity of the involuntary muscles, has an important use with respect to the mucous surfaces, which it relieves of the fluids that load them, and whose

presence becomes painful. Where the mucous surfaces have not around them fleshy layers of the involuntary muscles, as in the bronchia, the nasal fossæ, &c. the muscles of animal life more or less distant, perform this function, as for example, the diaphragm and the intercostals, free the bronchial surface by coughing, and the pituitary by sneezing.

As we recede from the period of birth, the organic muscles grow in general much less in proportion than the others; it is this that gradually re-establishes the equilibrium between the two systems. I would remark however, as it respects the predominance of the first, that it is much less conspicuous in the fœtus than that of the nervous system. The brain, for example, is in proportion much larger than the heart.

It is probable that the muscles of which we are treating, exhibit, at this period, the same varieties of composition as the others, that gelatine especially predominates in them, that they have less fibrin, &c. This last substance perhaps exists, in the early periods, more abundantly in the heart than in the other muscles of this class.

We have observed two very distinct periods in the growth of the other muscles; one is finished when they have acquired their length; the other, when their thickness is complete. The first has not, in the organic system, a term as distinct; when the stature no longer increases, the gastric and urinary organs, and the heart still lengthen and grow.

We have considered growth in too general a manner. Each system has a different term in this great phenomenon. The osseous and muscular systems of animal life, and those which depend on them, as the fibrous, the cartilaginous, &c. have especially an influence upon the general stature of the body; it is these which produce this or that height; but this height has no influence upon the length of the intestines, or the capacity of the stomach,

the heart, the bladder, &c. The glandular, serous, mucous systems, &c. are equally independent of stature; thus in these numerous varieties, it has much more influence upon the extremities, than upon the abdomen, the thorax, &c. A great height indicates the predominance of the apparatus of locomotion, but not of those of digeson, respiration, &c. The termination of the growth in height, which we consider in a general manner for the whole body, is only the termination of the growth of the muscles, the bones and their dependancies, and not of that of the internal viscera, which still lengthen and become thicker. It is easy to be convinced of this, by comparing the organic muscles of a young man of eighteen years, with those of a man of thirty or forty.

The organic muscles do not appear to be subject to those irregularities of growth which the other muscles and the bones frequently exhibit. We know that the stature often remains stationary for many years, and that suddenly it acquires very great dimensions in a very short time; this phenomenon is remarkable especially after long diseases. Now notwithstanding these inequalities, the heart and all the other analogous muscles grow in an uniform manner; the regularity of the internal functions to which these muscles especially contribute, could not adapt itself to those aberrations which would be unable to disturb the functions of the locomotive organs. Besides, if they took place, the circulation, digestion, excretion of urine, &c. would exhibit corresponding aberrations; now this is never observed. The heart and the gastric muscles, &c. always grow in an infant whose stature remains stationary; they do not grow suddenly in one who grows at once; hence why the thorax and the abdomen become large in the first case, and remain contracted in the second in proportion to the extremities.

Besides these two systems are never in precise relation of nutrition and power. I have already observed that

very large organic muscles often exist with very small voluntary ones, and vice versa.

Let us consider neither the growth nor nutrition in an uniform manner; each system is developed and increases in its own way; all are never found at the same periods of this function. Why? because nutrition, like all the other acts over which life presides, is essentially dependant on the vital forces, and these forces vary in each system.

The growth of the involuntary muscular system is not uniform in all the organs which compose it. Each increases more or less, or is differently developed; one often predominates over the others in an evident manner; a bladder with strong, fleshy fibres, with columns as they are called, is often found in a subject with a debilitated stomach, with small intestines, &c.; reciprocally, the stomach, the heart, &c. have often an insulated predominance.

III. *State of the Organic Muscular System after Growth.*

It is from the twenty-fourth to the twenty-sixth year, that the organic muscles are completely developed. Then the thorax and the abdomen which contain them have their greatest capacity. These muscles are then as they are to remain through life; they have a density much greater than in youth; their power is increased and their colour is deeper. In general this is subject in the heart to frequent varieties, which coincide very nearly with the varieties of the preceding system. Acute and chronic diseases have nearly the same influence upon it. It is equally the index of the sanguineous, lymphatic temperaments, &c. by the different tinge it assumes. The colour of the gastric, intestinal and vesical fibres varies less; their whiteness, more uniform, is rarely influenced by diseases.

We cannot increase, by constant exercise, the nutrition of the organic muscles. Aliments taken beyond measure, making the stomach frequently contract, weaken it instead of developing its fibres more, as happens from constant exercise given to a superior or inferior extremity. The bladder incessantly in action in some cases of incontinence, is thus gradually weakened and loses its energy. We might say that these two systems were in this respect in an inverse order.

It appears that the nutrition of the organic muscles, like that of the others, is subject to frequent variations; that at some periods they are more developed and less so at others. Diseases have a great influence upon this phenomenon, which proves, like the softening of the bones and their return to the natural state, the constant composition and decomposition of which these organs are the seat. We find in the dissecting rooms many differences in different subjects, as it respects the colour, density and cohesion of the muscles. Now what many exhibit then at once, the same individual often experiences successively; the same man no doubt has, according to the different influences to which he is exposed, his heart red, dense, large and well nourished at one period of life, and feeble, pale and small at another; for the internal organs experience the same alterations as the exterior. Now we know that the external appearance often changes during life.

IV. *State of the Organic Muscular System in Old Age.*

As we advance in age, the muscular system of which we are treating becomes weak like all the others; yet its action is more durable; it survives, if we may so say, that of the other. When the old man, almost immoveable, crawls about but slowly and with pain, his pulse, digestion, &c. have vigour still. This difference of the

two systems is so much the more remarkable, as the time of activity of the second is almost by half less than that of the first; sleep cuts off in fact almost half of the duration of the voluntary motions, whilst it leaves the involuntary wholly untouched. This phenomenon of the organic muscles as it were surviving the voluntary in the last periods of life, is derived on a great scale from the same principle from which arises on a small one the lassitude which follows the contraction in an insulated motion. A less durable motion is necessary to fatigue the voluntary muscles, than to fatigue the involuntary; the stomach empty remains for a long time contracted upon itself without producing any painful sensation, whilst if we hold a body strongly grasped between our fingers for a quarter of an hour, all the flexors are soon painfully affected. After a convulsion of half an hour, in which all the locomotive muscles have been stiff, the whole body is broken, as it is called; it cannot admit of any motion; whilst after a paroxysm of fever of six or eight hours in which the pulse has been violently agitated, the heart often preserves the natural type of its contractions; it requires repeated paroxysms to weaken it. All these phenomena of the two muscular systems evidently prove that that of animal life is fatigued much the soonest; it is this which occasions its intermission. Is it then astonishing that, although less often in exercise than the other, it exhausts sooner the quantum of force nature has given to it? is it astonishing that the other survives the longest? Life is a great exercise which gradually wears up the organs in motion, and which requires their rest; this rest is death; now each moveable organ arrives at it sooner or later, according to the different degree of the forces which it has to expend, and according to its greater or less disposition to be wearied by this great exercise.

Yet the organic muscles are gradually weakened. The pulse becomes slower, digestion is longer in old age; the

bladder and rectum first cease to act; then the intestines remain inactive; the stomach and especially the heart die the last.

A long time before death, the muscular cohesion is weakened in this system as in the preceding; the fleshy texture becomes flaccid; the parietes of the heart support themselves in youth; they flatten in old age. The gastric system of a young animal suddenly killed during hunger is firm, dense and contracted upon itself; in an old one, under the same circumstance, it is but little contracted; the stomach and intestines remain much more dilated; they are loose and soft; it is the same phenomenon as in the preceding muscles, which vacillate under the skin, from want of cohesion. The bladder remains constantly large, though empty.

MUCOUS SYSTEM.

THIS system, the name of which I borrow from the fluid that constantly lubricates it, and which is furnished by small glands inherent in its structure, appears everywhere in a membranous form ; that of fasciculi is wholly foreign to it. In speaking of the mucous organs we shall designate them almost always under the name of membranes. Their study is a new object of research. Pinel has been among the first, who has perceived the necessity of considering them in a general manner as it respects diseases. I believe that I am the first who has regarded them generally in an anatomical and physiological view. Few systems deserve more attention ; upon it take place all the great phenomena of digestion, respiration, secretion, excretion, &c. ; it is the seat of many diseases. It should alone, in a nosography in which diseases are distributed by systems, occupy a place equal to that of many.

ARTICLE FIRST.

OF THE DIVISIONS AND FORMS OF THE MUCOUS SYSTEM.

THE mucous membranes occupy the interior of the cavities which communicate with the skin by the different openings this covering has on the surface of the body.

Their number at first view is very considerable; for the organs in which they are reflected are very numerous. The mouth, the stomach, the intestines, the œsophagus, the bladder, the urethra, the womb, the ureters, all the excretories, &c. &c. derive from these membranes a part of their structure. Yet if we consider that wherever they are continuous, wherever we see them originate, by extending from each other, as they originated in the first instance from the skin, we shall perceive that this number must be wonderfully limited. In fact by thus describing them, not separately in each part, but at the same time in all those upon which they are continued, we see that they are reduced to two general surfaces, of which all the others are portions, and which, on account of the different parts to which they are distributed, can be called, the one gastro-pulmonary, the other genito-urinary. The first is found in the head, the neck and the abdomen. This last cavity and more especially the pelvis, contain the second.

There is also a small insulated mucous surface; it is that which enters by the openings of the nipples and lines the lactiferous tubes. But it is so small that it deserves but little attention; besides, what will be said of the two others will be equally applicable to it. It is then useless to examine it in a general manner.

I. *Of the two General Mucous Membranes, the Gastro-Pulmonary and the Genito-Urinary.*

The gastro-pulmonary surface penetrates into the interior by the mouth, the nose and the anterior face of the eye. 1st. It lines the first and second of these cavities, extends from the first to the excretory ducts of the parotid and sub-maxillary glands, from the other into all the sinuses, forms the conjunctiva, dips down into the puncta lachrymalia, the nasal duct, the sac of the same name, and is continued into the nose; 2d, it descends into the

pharynx, furnishes an elongation to the Eustachian tube, then penetrates the internal ear and lines it, as we shall see; 3d, it dips down into the trachea and is spread upon all the air-tubes; 4th, it penetrates into the oesophagus and the stomach; 5th, it extends to the duodenum where it furnishes two elongations, one destined to the ductus choledochus, to the numerous branches of the hepatic and cystic ducts and the gall-bladder, the other to the pancreatic duct and its different branches; 6th, it is continued into the small and large intestines and finally terminates at the anus where we see it identified with the skin.

The second general mucous membrane, which we have called the genito-urinary, enters in man by the urethra, and thence is spread on the one hand upon the bladder, the ureters, the pelvis of the kidnies, the infundibula, the papillæ and the capillary tubes which open on their summit; on the other hand it goes into the excretory tubes of the prostate, into the seminal ducts, the vesiculæ seminales, the vasa deferentia and the branches with numberless windings that produce them.

In woman, this membrane is introduced by the os externum and penetrating on the one hand by the urethra, goes as in man upon the urinary organs; on the other hand, we see it enter the vagina, lining it, the uterus and the fallopian tubes, and afterwards becoming continuous with the peritoneum by the opening of these tubes. It is the only example in the economy, of a communication established between the mucous and serous surfaces.

This manner of describing the course of the mucous surfaces, by saying that they are elongated, dip down, penetrate, &c. from one cavity to another, is no doubt not conformable to the progress of nature, which creates in each organ the membranes belonging to this organ, and does not thus extend them by degrees; but our manner of understanding it is better adapted to this language, the meaning of which the least reflection will show.

In thus referring to two general membranes all the mucous surfaces, I am not only supported by anatomical inspection, but pathological observation has also furnished me with points of demarcation between the two, and points of contact between the different portions of membranes of which each is the assemblage. In the different descriptions of catarrhal epidemics given by authors, we frequently see one of these membranes affected in all parts, the other remaining sound; it is especially not rare to observe a general affection of the first, of that which extends from the mouth, the nose, the surface of the eye, into the alimentary canal and the bronchial vessels. The last epidemic observed at Paris, with which Pinal himself was affected, was of this character; that of 1761, described by Razou, had it also; that of 1752, described in the memoirs of the Society of Edinburgh was remarkable for a similar phenomenon; now, we do not see at that time a corresponding affection in the mucous membrane that is spread upon the urinary organs and upon those of generation. There is then here, 1st, an analogy between the portions of the first, by the uniformity of affection; 2d, a demarcation between the two by the health of the one and the disease of the other.

We see also that the irritation of any one point of one of these membranes, frequently produces a pain in another point of the same membrane, which is not irritated. Thus a calculus in the bladder occasions a pain at the end of the glans penis, the presence of worms in the intestines causes an itching of the nose, &c. &c. Now, in these phenomena purely sympathetic, it is very rare that the partial irritation of one of these two membranes affects with pain one of the parts of the other; there are however examples of it; such is the singular relation that exists, in mucous hemorrhages, between the membrane of the womb and that of the bronchia. If the blood ceases accidentally to flow from one during menstru-

ation, the other frequently exhales it and thus as it were supplies its functions.

We ought then, from inspection and observation, to consider the mucous surface, in general, as formed by two great membranes successively spread upon many organs, having between them no communication except by the skin, which serves them as an intermediate organ, and which, continuing with both, contributes thus with them to form a general membrane everywhere continuous, covering the animal externally, and extending within upon most of its essential parts. We can conceive that there should exist important relations between the internal and external portion of this single membrane; and that they do will be proved by further researches.

II. *Adhering Surface of the Mucous Membranes.*

Every mucous membrane exhibits two surfaces, one adhering to the neighbouring organs, the other free, covered with villi, always moistened with a mucous fluid. Each deserves particular attention.

The adhering surface corresponds almost everywhere with the muscles, either of animal or organic life. The mouth, the pharynx, the whole alimentary canal, the bladder, the vagina, the womb, a portion of the urethra, &c. exhibit a muscular layer embracing on the outside their mucous tunic which is within. This arrangement coincides perfectly, in animals with a fleshy membrane, with that of the skin, which moreover approximates very near, as we shall see, the structure of the mucous membranes, and which, as we have seen, is everywhere continuous with them. This arrangement of the mucous membranes occasions them to be agitated by constant motions which favour wonderfully the secretion that takes place in them, the excretion which succeeds it, and the various other functions of which they are the seat. The

insertion of this muscular layer exterior to the mucous system, is made, as we have seen, by this dense and compact texture which I have called the sub-mucous. It is from this texture, more compact than the rest of the cellular system, that the mucous surface derives its force. It is from it that the organ which it lines receives its form; it is this which supports and preserves this form; the following experiment proves it. Take a portion of the intestine; remove from any part of it this layer, as well as the serous and the muscular; then inflate it, after having tied it below; the air produces in this place a hernia of the mucous coat. Try afterwards another portion of intestine; deprive this, for a small space, of its mucous membrane and of this also; inflation will produce upon the serous and muscular tunics the same phenomenon that it did in the preceding on the mucous; then it is to this sub-mucous cellular layer that it owes the resistance with which it opposes substances that it contains. The same may be said of the stomach, the bladder, the œsophagus, &c.

III. *Free Surface of the Mucous Membranes.*

The free surface of the mucous membranes, that which is continually moistened by the fluid from which they borrow their name, exhibits three species of wrinkles or folds.

1st. One inherent in the structure of all the laminæ of these membranes, is constantly met with, whatever may be their state of dilatation or contraction; such are those of the pylorus and the valve of Bauhin. These folds are formed not only by the mucous membrane, but also by the intermediate tunic of which we have spoken, which here has a remarkable density and thickness, and gives them solidity. The fleshy tunic enters even into their composition, and we see on the exterior, upon the serous surface, a depression that indicates their presence.

2d. Other folds, only formed by the mucous surface, exist also always in a state of vacuity or fulness, less evident however than this; they are owing to the circumstance that the mucous surface is much more extensive than those upon which it is applied, so that it is folded that it may not run a longer course; such are the valvulæ conniventes of the small intestines, the structure of which we see very well by cutting longitudinally one of these intestines. The edge of the section exhibits the fleshy layer and the serous surface in a straight direction, whilst the mucous layer describes a line resembling a loose thread.

3d. The last species of folds is as it were accidental, and is only observed during the contraction of the organ which is lined by the mucous surface that is the seat of it; such are those of the interior of the stomach, the great intestines, &c. In the greatest number of subjects brought to the dissecting rooms, these folds of which so much has been said as it respects the stomach, cannot be perceived in it, because the subject has died after a disease that has so altered the vital forces, as to prevent all action of this viscus; so that though it is frequently found empty, its fibres are not contracted. In experiments upon living animals, on the contrary, these folds become very evident, and may be demonstrated in this way; make a dog eat or drink copiously, open him an instant after and cut the stomach in the length of its great curvature; no fold is then apparent; but soon the viscus contracts, its edges are turned over and the aliments escape; the whole mucous surface is covered with an infinite number of very prominent ridges, which have as it were the form of cerebral circumvolutions. We obtain the same result by taking out the stomach of an animal recently killed, distending it with air and opening it afterwards, or by cutting it immediately in its state of vacuity and drawing it in opposite directions by its edges; it stretches, its ridges disappear, and if we cease to dis-

tend it, they form again immediately in an evident manner. I would observe on the subject of the inflation of the stomach, that by distending it with oxygen, we do not produce by the contact of this gas, greater ridges and consequently a stronger contraction, than by using for the same purpose carbonic acid gas. This experiment furnishes a result very similar to what I have observed in rendering animals emphysematous by different aeriform fluids. It follows from all that we have said upon the folds of the mucous membranes, that in the ordinary contraction of the hollow organs which these membranes line they undergo but a very slight diminution of surface, that they contract scarcely at all, but fold within, so that by dissecting them on an organ in contraction we should have a surface almost equal in extent to that which they exhibit during its dilatation. This assertion, which is true as it respects the stomach, the œsophagus and the great intestines, is not perhaps as entirely so with regard to the bladder, the contraction of which makes the ridges within less evident; but they are not sufficient to destroy the general law. It is also nearly the same with the gall-bladder; yet here we find another cause. The gall-bladder, alternately observed in hunger and during digestion, contains double the bile in the first case that it does in the second, as I have had occasion to see very often indeed, in experiments made for this object or with other views. Now, when the bladder is in part empty, it does not contract upon the bile that remains, with the force of the stomach when it contains but few aliments, or with the power of the bladder when it contains but little urine. It is then flaccid; so that its being distended or not has but a slight influence upon the folds of its mucous membrane.

Besides, in saying that the mucous membranes always exhibit, with some slight difference, the same surface in the extension and contraction of their respective organs, I intend to speak only of the ordinary state of the func-

tions, and not of those enormous dilatations of which we often see the stomach, the bladder, and more rarely the intestines become the seat. Then there is no doubt, a real extension and contraction, which coincide in the membrane with those of the organ.

A remarkable observation which the free surface of the mucous membranes exhibits, and which I have already pointed out, is, that this surface is everywhere in contact with bodies heterogenous to that of the animal, whether these bodies introduced from without to nourish it have not yet been assimilated to its substance, as we see in the alimentary canal and in the wind-pipe ; or whether they come from within, as we observe in all the excretory ducts of the glands, which all open into cavities lined by the mucous membranes, and transmit without particles which, after having contributed for some time to the composition of the solids, become heterogeneous to them, and are separated from them by the constant motion of decomposition which takes place in living bodies. Hence we ought to regard the mucous membranes as limits, and barriers, which, placed between our organs and the bodies that are foreign to them, defend them from the mischievous impression of these bodies, and serve consequently within, the same functions which the skin performs without, with respect to the bodies which surround that of the animal, and which tend incessantly to act upon it.

The organization of the mucous system and its vital properties are accommodated to this habitual contact of substances heterogeneous to the living economy. That which is a foreign body to the other systems, the cellular, the muscular, &c. is not so to this. Solid substances, the metals, stones, wood, &c. which introduced into our parts excite in them inevitably suppuration and an antecedent inflammation by their simple contact, pass with impunity over this, provided that their angles and asperities do not

tear it; they only augment a little the secretion, as I shall say. We can swallow a ball of lead, of wood, &c. and pass it by the anus without inconvenience. All the irritating fluids without being caustic, that we inject into the great intestines in enemas, or that we swallow, would produce abscesses, &c. if they were forced into the cellular system, &c. Surgeons employ the term foreign bodies in too general a manner; that which is so for one system, is not for another. Foreign is, in this respect, a term of comparison which we should employ only after a knowledge of the peculiar sensibility of each system, and not after that of this property described in a vague manner.

The mucous system not only bears without danger the presence of all bodies that are introduced into the economy, but also when it goes out, it can be exposed with impunity to the contact of external stimuli. Observe what takes place in prolapsus of the womb in which the whole membrane of the vagina sometimes becomes external, in those inversions of the intestinal tubes that take place through preternatural ani, in prolapsus of the rectum, &c.; then the mucous surfaces serve really as integuments; now in these cases the surrounding bodies produce hardly any more pain on them than upon the skin. On the contrary, the instant a serous surface is laid bare, as for example in the operation of hernia, in which the intestine is suffered to come out, on account of an opening unfortunately made by the point of a bistoury, this surface inevitably inflames. All the cellular, muscular, nervous, glandular systems, &c. laid bare, exhibit the same phenomenon. There is no danger in opening the bladder as it respects the contact of the air, whilst there is much in permitting this fluid to penetrate into an articular cavity, a tendinous groove, a serous sac, &c. We know how much in the high operation for the stone, we fear to wound the peritoneum, how uncertain are the results of empyema on account of the contact of the air

upon the pleura, &c. The dangers of the action of this fluid upon these surfaces have been perhaps exaggerated, but they are notwithstanding real.

If a fistula extends from the exterior of the abdomen into the intestines, its whole course is lined with callous bodies; these defend the cellular texture and the muscles through which the fistula passes. On the contrary, nothing similar appears upon the intestinal mucous surface, because its organization alone is sufficient to protect it. The urinary, salivary and lacrymal fluids never escape externally by artificial ducts formed in the neighbouring organs, without there are similar callous bodies in the course of these ducts; on the contrary, they pass with impunity over the mucous surfaces. Make in a limb a long and straight opening with a pointed instrument, and fix in it for a time a sound; a callous canal will be produced by it. Let a sound on the contrary remain in the urethra, no alteration of texture will result from it.

Let us conclude from these different considerations, that the mucous system with the cutaneous alone, is organized so as to support the contact of all external bodies, and not to be affected by their presence, or at least experience only an increase of secretion, which is in no ways dangerous. Thus these two systems form two boundaries, the one internal and the other external, between which are placed the organs foreign, by their mode of sensibility and by that of their structure, to the external bodies. To these boundaries the excitement of these bodies is limited; their influence does not go beyond. So long as they do not pass these boundaries, the other organs do not feel them. We might say that the acute sensibility which each of them enjoys, is a kind of sentinel that nature has placed on the confines of the organic domain of the mind, to inform it of whatever can injure it.

ARTICLE SECOND.

ORGANIZATION OF THE MUCOUS SYSTEM.

I. *Texture Peculiar to this Organization.*

The mucous system presents two things to be considered in its peculiar texture, viz. 1st, a layer more or less thick which constitutes principally this texture, and which by analogy with the cutaneous corion, may be called the mucous corion; 2d, many small elongations which surmount it, and which are called villi or papillæ. As to the epidermis which covers it, I shall treat of it with the cutaneous epidermis. This texture has nothing similar to the substance that colours the skin, and which is between the papillæ and epidermis. We know in fact that negroes, as well as whites, have this texture of a bright red, which it derives from its vessels.

Mucous Corion.

This portion of the mucous texture, which is the most important, and which constitutes the thickness, form, and even the nature of it, has a soft and spongy appearance. We might say at first view that it was a consistent pulp, with which the extremely dense cellular texture that is subjacent to it had been covered. This softness is a character which distinguishes it from the cutaneous corion, which moreover has by its intimate nature but little resemblance to it.

The mucous corion is very various as to thickness; it differs in this respect in each organ. That of the gums and the palate is the thickest of all. Then come those of

the nasal fossæ and the stomach, then those of the small intestines and the gall-bladder, then those of the large intestines, of the urinary bladder, the urethra and the other excretories, until it begins at length to become so fine as to appear transparent like a serous surface when it is removed with care. Finally, the finest and most delicate is that of the sinuses of the face and the interior of the ear; the arachnoides is often coarser.

I have called the texture within the ear mucous, though all anatomists call the membrane of the cavities of this organ periosteum. In fact, 1st, we see it evidently continued with the pituitary membrane, by means of the elongation of the Eustachian tube. 2d. We find it constantly moistened by a mucous fluid which this canal serves to convey out, a character foreign to the periosteum, which, like the fibrous membranes, always adheres by both its surfaces. 3d. No fibre can be distinguished in it. 4th. Its fungous appearance, though white and soft, and the ease with which it is torn, are evident attributes of the mucous membranes. Every thing proves that the membrane of the tympanum, that of the meatus, &c. belong to the system of which we are treating. Thus in catarrhs of the pituitary membrane, and of that of the fauces, we most often find that the ear is affected; thus the ear is, like the mucous surfaces, the seat of hemorrhage, thus polypi arise in it, as in the nose and on the surface of the womb. We consider as a sign of deposition of pus in the ear, every purulent discharge coming from that cavity. But how can we conceive of a purulent collection in a part in which there is hardly any cellular texture, in a part wholly osseous? Besides the fibrous system, to which the periosteum of the tympanum belongs, hardly ever suppurates, as we know. Every thing then induces us to believe that these discharges are only the effect of a catarrh of the ear, a catarrh which is sometimes acute and sometimes chronic. I have more-

over a recent and decisive fact upon this point; the body of a man subject to these discharges during life exhibited a remarkable thickness and redness of the membrane of the tympanum, but without the least trace of erosion. The ear suppurates like the urethra, the vagina, &c. it is not a new fluid which is formed by suppuration; it is that which naturally comes from the meatus which increases in quantity and comes through a preternatural opening of the membrane of the tympanum.

Diseases make the thickness of all the mucous surfaces vary remarkably. I have seen them many lines thick in the maxillary sinus, and nearly half an inch in the bladder. In great extensions of the mucous sacs, this thickness diminishes very much; it increases in their contractions. The stomach especially exhibits this phenomenon in these two opposite states.

The softness of the mucous corion is also very variable; in the nasal fossæ, in the stomach and the intestines, it is really a kind of organized velvet. The name of villous membrane is perfectly suited to it. On the contrary, at the origins of the mucous system, as in the mouth, upon the glans penis, at the entrance of the nose, it is a more dense and compact texture, approximating nearer in its nature to the cutaneous corion. I am persuaded that like this it might be tanned and be useful in the arts if it were in larger pieces, whilst I doubt if the action of tanning could produce an analogous phenomenon upon the mucous texture of the deep-seated organs. The softness of this would render it incapable of serving for external integuments. The least cause would be in fact sufficient to break and tear it. Its structure being different from that of the cutaneous corion is the reason that the variolus pustules never appear on it, whilst we often see them on the mucous surfaces near the openings of the skin, especially upon the tongue, the palate and the internal surface of the cheeks.

Exposed to the action of dry air, so that it may come everywhere in contact with it, it becomes dry and very thin, but preserves some resistance. In bladders inflated and dried, in the stomach, the intestines, &c. thus prepared, it is this texture which supports these organs, and which prevents them from becoming flat, though we permit the air to escape; it offers even a resistance, from which arises a kind of crepitation when we wish to bend them in various directions. To be convinced of this, it is only necessary to dry the mucous surface separate from the serous and muscular that correspond with it; these when dried remain pliable like the cellular texture, whilst the first has a kind of rigidity.

In the organs in which the redness of the mucous texture is slight, as in the bladder, the rectum, &c. it becomes transparent by drying. Where it is very red as in the stomach, it takes a deep tinge, which becomes even almost black if there had been an antecedent inflammation in it by which much blood had been accumulated; hence it appears that this fluid is the cause of the colour.

Thus dried the mucous surfaces are smooth; they lose their viscidity at least in appearance; their folds are effaced by adhering to the surface from which they arise; thus the valvulæ conniventes are marked in a dried intestine, only by a red line, without any apparent prominence. But if we macerate the intestines in this state, the folds form again and become visible.

Exposed to a moist air, or left with other flesh that will not allow it to become dry, the mucous corion putrefies with great ease; the odour that it then sends out is very fetid. I think the reason why the abdomen of dead bodies becomes putrid so soon is in part because it contains substances already in putrefaction, and also because the surfaces, in contact with these substances, and which by their vitality resisted before their action, then readily yield to them. If these substances were contiguous to aponeu-

roses, putrefaction would be much less rapid. The mucous system when putrid takes a greyish colour; and as the dense, subjacent cellular texture putrefies much less easily, we can then remove from it by the least pressure, the mucous corion, reduced to a putrid pulp, in which every trace of organization has disappeared, and which forms a real pap.

During life, gangrene of the mucous texture takes place in general less frequently than that of the cutaneous. The consequences of catarrh, compared with those of erysipelas may convince us of this; there are however cases in which death appears in this texture, whilst the surrounding ones continue to live, as in gangrenous angina.

Exposed to maceration, the mucous texture yields to it promptly. I think that next to the brain it is altered quickest by the action of water. It is then reduced to a reddish pulp very different from that from putrefaction in the open air. When we put the whole stomach to macerate, this pulp is detached, when the sub-mucous texture and the serous membrane have as yet undergone but little alteration.

Ebullition at first extracts from the mucous texture a greenish scum, very different from that which the muscular and cellular textures give when boiled. This scum which mixed with the whole fluid in the beginning of the boiling, disturbs it and renders it green at first, afterwards rises upon the surface where it has small bubbles of air mixed with its substance; it often even falls to the bottom of the vessel by its weight. Sulphuric acid changes the colour of it to a dull brown.

A short time before the water begins to boil, the mucous texture crisps and acquires the horny hardness like the others, but in a less degree however; hence why it is then wrinkled almost always in different directions. In fact, the sub-mucous texture upon which it is applied,

contracting at that time much more than it, it must fold on account of its length; thus during life, when the fleshy coat of the stomach contracts, its mucous surface not contracting in proportion, produces the numerous folds of which we have spoken. The action of a concentrated acid crisping the sub-mucous texture more than the mucous itself, produces an analogous phenomenon. After having been a long time dried, the mucous texture, like however almost all those of the animal economy, does not lose the faculty of acquiring the horny hardness when it is plunged into boiling water; it exhibits this phenomenon, whether we expose it to it dry, or whether we do it after having first softened it in cold water. It is a means by which all the valvulæ conniventes may be made suddenly to reappear, which had disappeared by drying, and which form again the instant the intestine contracts. This experiment is very curious to witness.

When the ebullition has been a long time continued, the mucous texture turns gradually to a very deep grey, from the white which it had first become. It is not softer than in the natural state, but it breaks much quicker; the following experiment is a proof of it. If we draw the mucous corion, boiled for some time with the subjacent cellular texture, this last resists the most; so that it remains entire, whilst the mucous corion is broken in many places. This never assumes the gelatinous appearance of the cutaneous corion or the fibrous and cartilaginous organs when boiled and of the others which yield much gelatine. However by mixing a solution of tannin with the water in which this system taken from an adult has been boiled, I have seen an evident precipitate.

The action of the acids reduces to a pulp the mucous texture much sooner than most of the others. During life, all the caustics act much more rapidly upon it than upon the cutaneous, of which the thick epidermis is an intermediate organ which checks their tendency of com-

bining with its corion. Thus the instant the nitric acid, a substance which common people almost always choose for their poison, as the practice at the Hôtel Dieu proves, thus the instant I say, that the nitric acid is in contact with the alimentary canal, it disorganizes it, it forms there a whitish eschar, which, when death does not take place immediately, as most often happens, is slowly removed and detached in the form of a membrane. We know that the lips gently rubbed with weakened nitric acid, become the seat of a troublesome itching, whilst that oftentimes though this acid may have acted upon the skin sufficiently to make it yellow, it does not suffer from it.

The softness of the mucous corion makes me presume that it is easily altered by the digestive juices, not that I confide in the experiments of Hunter, who pretended that these juices could act upon the coat that secretes them, but because in general I have observed that the textures like it yield very easily to the action of water in maceration and are also very easily digested. I have not however any experiment upon the subject, and we know that in the animal economy analogy is not always a faithful guide.

All the mucous surfaces, but especially that of the stomach and intestines, have the property of curdling milk, as have many other substances, especially the acids. Is it to this property that must be attributed a phenomenon which is constant during life, viz. the coagulation of milk that enters the stomach for digestion? or is this phenomenon owing to the mixture of this fluid with those which are secreted by the surface of this organ? I think that both these causes contribute to it at the same time; both separate produce in fact this phenomenon. Spallanzani has proved it as it respects the gastric juices. Every body knows that the mucous membrane dried, and consequently deprived of these juices, preserves the property of coagulating milk. Spallanzani has convinced

himself that the serous and organic muscular systems of the stomach are destitute of it.

Are aphthæ an affection of the mucous corion? do they belong to the papillæ? are they seated in the glands? are they a separate inflammation of these glands, whilst catarrhs are characterized by a general inflammation of a considerable extent of the mucous system? All these questions deserve to be examined. Pinel has perceived the void there is in morbid anatomy upon this point.

Mucous Papillæ.

The peculiar kind of sensibility which the skin enjoys is attributed principally, as we know, to what is called the papillary body, which commonly is not easy to be demonstrated. The sensibility of the mucous membranes, somewhat analogous to that of the skin, appears to me to have the same kind of organization, which is perceived with infinitely less ease. The papillæ of this system cannot be called in question at its origin, where it dips into the cavities, in the commencement even of these cavities, as upon the tongue, the palate, the internal part of the alæ of the nose, upon the glans penis, in the fossa navicularis, within the lips, &c. Inspection is sufficient to demonstrate them there. But it is asked if the papillæ exist also in the deep-seated parts of this system. Analogy indicates it, since the sensibility is as great there as at their origin, though with varieties that we shall point out; but inspection proves it in a manner not less certain. I think that the villi with which we everywhere see them covered are nothing but these papillæ.

Very different ideas have been entertained of the nature of these villi; they have been considered in the stomach and the œsophagus as destined to the exhalation of the gastric juice, in the intestines as serving for the absorption of chyle, &c. But, 1st, it is difficult to conceive how an organ everywhere nearly similar, can perform in

different parts functions so different; I say nearly similar, for we shall see that these papillæ exhibit differences of length, size, &c. without having any of texture or structure. 2d. What can be the functions of the villi of the pituitary membrane, of the internal coat of the urethra, the bladder, &c. if they have not relation to the sensibility of these membranes? 3d. The microscopical experiments of Leiberkuhn upon the vesicle of the intestinal villi have been contradicted by those of Hunter, of Cruikshank and especially of Hewson. I am certain that I have never seen any thing similar on the surface of the small intestines, at the time of chylous absorption; and yet it would appear that a thing of inspection could not vary. 4th. It is true that these intestinal villi are everywhere accompanied by a vascular net-work, which gives them a red colour very different from the colour of the cutaneous papillæ; but the non-appearance of the cutaneous net-work is owing to the pressure of the atmospheric air, and especially to the contraction which it occasions in the small vessels. Observe in fact the fœtus as it comes from the womb of its mother; its skin is as red as the mucous membranes, and if its papillæ were a little longer, it would resemble almost exactly the internal surface of the intestines. Who does not know moreover, that the vascular net-work surrounding the cutaneous papillæ, is rendered evident by fine injections, so as to change their colour entirely?

That in the stomach this vascular net-work continuous with the exhalants furnishes the gastric juice, and that in the intestines it intermixes with the origin of the absorbents, so that these embrace the villi, we cannot doubt after the experiments and observations of anatomists who have recently engaged themselves in investigating the lymphatic system. But this does not prevent the base of these villi from being nervous, and them from performing upon the mucous membranes the same functions that

the papillæ do upon the cutaneous organ. This manner of regarding them by explaining their existence generally observed upon all the mucous surfaces, appears to me to be much more conformable to the plan of nature, than to suppose them in each place with different and often opposite functions.

Besides it is difficult to decide the question by ocular observation. The delicacy of these elongations conceals their structure, even from our microscopical instruments, agents from which anatomy and physiology do not appear to me to have derived much assistance, because when we see obscurely, each sees in his own way and according to his own wishes. It is then the observation of vital properties that should especially guide us; now, it is evident to judge by them, that the villi have the nature I have attributed to them. The following experiment served to demonstrate to me the influence of the papillary body upon the cutaneous sensibility; it succeeds also upon the mucous membranes. Remove the epidermis in any part and irritate the papillary body with a sharp stilet; the animal is agitated, cries out and gives marks of acute pain. Slide afterwards, through a small opening made in the skin, a pointed stilet into the subcutaneous cellular texture, and irritate the internal surface of the corion; the animal remains quiet and makes no noise, unless some nervous filaments accidentally struck make him suffer. Hence it follows very evidently, that it is upon the external surface of the skin that its sensibility resides, that the nerves pass through the corion without contributing to its texture, and that their expansion takes place on the papillary body. It is precisely so with the mucous surfaces. Observe that this circumstance coincides very well with the functions of the two surfaces, which receive by their free portion the action of external bodies, to which they are foreign by their adhering portion.

The papillæ exhibit very great varieties. On the tongue, in the small intestines, in the stomach and in the gall-bladder, they are remarkable for their length. The œsophagus, the large intestines, the bladder, all the excretory ducts have those that are less evident; these last especially and the urethra in particular, are almost smooth in their whole mucous surface. We can scarcely distinguish the papillæ in the frontal, sphenoidal, maxillary sinuses, &c.

These small nervous eminences are sufficiently distinct and separate upon the tongue. In the nasal fossæ, the stomach and the intestines, they are so near together and at the same time so delicate, that the membrane has at first view an uniform and smooth apppearance, though it is covered with these elongations. Each papilla is simple; no bifurcation is ever observed at its extremity. All appear to have a pyramidal form, if we can judge at least by those which are the most evident.

Are they susceptible of a species of erection? It has been believed with regard to those of the tongue, which become erect, it is said, to perceive tastes, and with regard to those of the nose, which receive odours more efficaciously in this state of erection, which is in the sensitive phenomena on a small scale, what the erection of the corpora cavernosa is on a large one. I do not believe that any exact experiment can prove this fact. Moreover, it would be necessary then that the intestinal, vesical papillæ, &c. should be in permanent erection, since they are almost always in contact with foreign substances.

II. *Parts common to the Organization of the Mucous System.*

Besides the blood vessels, the exhalants and the absorbents which contribute to the structure of this system as to that of all the others, it exhibits also a common organ,

which is found almost always separate elsewhere, but which is here especially designed for it. This common organ is of a glandular nature; we shall now examine it.

Of the Mucous Glands and of the Fluids which they secrete.

The mucous glands exist in all the system of this name. Situated beneath the corion or even in its thickness, they pour out incessantly through imperceptible openings a mucilaginous fluid which lubricates its free surface, and which defends it from the impression of the bodies with which it is in contact, and at the same time favours the course of these bodies.

These glands are very apparent in the bronchia, palate, the œsophagus and the intestines, in which they take the names of the anatomists who have accurately described them, and where they make in many places evident projections upon the mucous surface. They are less apparent in the bladder, the womb, the gall-bladder, the vesiculæ seminales, &c.; but the mucus that moistens them clearly demonstrates their existence. In fact, since on the one hand this fluid is analogous on all the mucous surfaces, and, on the other, in those in which the glands are apparent, it is evidently furnished by them, it must be secreted in the same way in those in which the glands are less evident. The identity of the secreted fluids supposes in fact the identity of the secretory organs. It appears that where these glands are hidden from our view, nature compensates for their delicacy by their number. Besides, there are animals in which, in the intestines especially, they form by their vast number, a kind of new layer, in addition to those of which we have spoken. In man this is remarkable in the palatine arch, in the pillars of the velum, on the internal surface of the lips, the cheeks, &c. &c. There is then this great difference between the mucous and the serous membranes, that the fluid which

lubricates one is furnished by secretion, whilst that which moistens the others is from exhalation.

The size of the mucous glands varies; those of the velum of the palate, those of the mouth, &c. are the largest; they become insensible in the greatest number of mucous surfaces. I dissected two subjects that died of a pulmonary catarrh, and in them the glands of the trachea and bronchia, which are, as we know, very apparent, were not enlarged; the membrane alone appeared to be affected. Besides, we do not yet know the injuries of these glands, like those of the analogous organs, which are more apparent from their size. They are in general of a rounded form but with many varieties. No membrane appears to cover them. They have, like the salivary glands and the pancreas, only the cellular texture for an envelope. Their texture is more dense and compact than these last glands; but little cellular texture is found in them; they are soft, vascular, and appear when opened very much like the prostate gland. I cannot say whether nerves penetrate them; analogy indicates it, for all the principal glands receive them.

Mucous Fluids.

We know but little of the composition of the mucous fluids, because in the natural state, it is difficult to collect them, and in the morbid, in which their quantity increases as in catarrhs for example, this composition is probably changed. We know that in general they are unsavoury, insipid, and but slightly soluble in water, in that even which is raised to the highest temperature; they become putrid with difficulty. In fact they remain a long time unchanged in the nose, exposed to the contact of a moist air; in the intestines, they serve, without danger to them, as an envelope for putrid substances, &c.; taken from the body and subjected to different experiments, they give results conformable to these facts. All

the acids act upon them and colour them differently; exposed to a dry air, they thicken by evaporation, and are often even reduced to small shining laminæ. The nasal mucus especially exhibits this phenomenon. Fourcroy has given in detail the analysis of this mucus; he has also given that of the tracheal mucus. But we must not apply rigorously to the analogous fluids our knowledge of the composition of these. It is sufficient in fact to examine a certain number of these fluids, to be convinced that they are not the same in any two places, that more or less thick, more or less uniform, different in their colour, their odour even, &c. they vary in the principles that constitute them, as the membranes which furnish them vary in their structure, in the number and size of their glands, in the thickness of their corion, the form of their papillæ, the state of their vascular and nervous systems, &c. I am far from being certain that the gastric juice is a mucous juice; it is even probable that exhalation furnishes it, the glands of the stomach throwing out a different fluid by the way of secretion. But this assertion is not accurately demonstrated, and perhaps hereafter it will be proved that this juice, so different from the other mucous juices, is however one of them, and that its properties are distinct only because the structure of the mucous surface of the stomach is not the same as that of the other analogous surfaces.

The functions of the mucous fluids in the animal economy are not ambiguous. The first of these functions is to defend the mucous membranes from the impression of the bodies with which they are in contact, and all which, as we have observed, are heterogeneous to that of the animal. These fluids form upon their respective surfaces a layer which supplies, to a certain extent, by its extreme tenuity, the absence of their epidermis. Thus where this membrane is very apparent, as upon the lips, the glans

penis, at the entrance of the nose and in general at all the origins of the mucous system, these fluids are not very abundant. The skin has only an oily layer, infinitely less evident than the mucous of which we are treating, because its epidermis is very distinct.

This use of the mucous fluids explains why they are more abundant where heterogeneous bodies remain some time, as in the bladder, at the extremity of the rectum, &c. than where these bodies are only to pass, as in the ureters, and the excretory ducts generally.

Hence why when the impression of a body would be injurious, these fluids are poured out in greater quantity upon their surfaces. The sound which enters the urethra and remains in it, the instrument that is left in the vagina to compress a polypus, that which remains some time with the same view in the nasal fossæ, the canal fixed in the lachrymal sac to remove the obstruction, that which is introduced into the œsophagus to assist interrupted deglutition, always produce, upon the portions of the mucous surface that corresponds to them, a more abundant secretion of the fluid which is constantly poured out, a true catarrh. This is one of the principal reasons that renders it difficult to keep elastic sounds in the wind-pipe. The abundance of the mucus that is then secreted, by closing the openings in the instrument, renders frequent introductions necessary, and can even threaten the patient with suffocation, as Desault himself has observed, though however he obtained great advantage from this means, as I have shown in his surgical works. I ought even to say, that since the publication of the Treatise on the Membranes, I attempted to fix a sound in the air tube of a dog, and that the animal died at the end of some time, having the bronchia filled with a frothy fluid which appeared to have suffocated him.

It appears then that every considerable excitement of the mucous surfaces produces a remarkable increase of

action. But how can this excitement, which does not take place immediately upon the gland, have so great an influence upon it? for, as we have said, these glands are always under the membrane, and consequently separated by it from the irritating bodies. It appears that it is owing to a general modification of the glandular sensibility, which is capable of being brought into action by any irritation upon the extremity of the excretory ducts, as I shall prove in the glandular system.

It is to the susceptibility that the mucous glands have of feeling the irritation made at the extremity of their ducts, that must be referred the artificial catarrhs with which Vauquelin has been affected by respiring the vapours of the oxy-muriatic acid, the mucous discharge that attends the presence of a polypus, of any tumour in the vagina, of a stone in the bladder, &c. the frequency of fluor albus in women who are immoderate in the use of sexual intercourse, the more abundant discharge of the mucus from the nostrils of those who take snuff, &c. In all these cases, there is evidently excitement at the extremity of the mucous ducts. I refer also to this excitement the mucous discharge that takes place, from stimulating the end of the nipple of a woman who does not give suck, the copious secretions which the presence of an irritating body produces in the intestines, secretions which especially furnish the matter of diarrhoeas, the gastric derangements which succeed an indigestion that has allowed to remain on the mucous surface of the stomach substances not digested and consequently irritating; these derangements are in fact real catarrhs of the membrane of the stomach, catarrhs which most often are not connected with bilious turgescence. I could add many other examples of the mucous secretions increased by an irritation upon the surface of the membranes, at the extremity of the excretory ducts; these will be sufficient to give an idea of the others.

All these excitements produce a kind of inflammation, the peculiarity of which is to contract at first for some time the glandular ducts, and arrest the secretion, which they afterwards excite in great quantity. When the mucous fluids have flowed abundantly for some time, they gradually diminish though the cause continues; thus less mucus is discharged from the urethra in proportion after the sound has remained in it a month, than when first introduced; but almost always as long as the cause continues, the mucous discharge is greater than in a natural state.

Blisters are much employed in medicine on the cutaneous organ, to dispel, according to some, the morbific humour, and overcome, according to others, a natural irritation by an artificial one. Why should we not also in many cases irritate the mucous surfaces? why not act upon the pituitary membrane, upon the glans penis, upon the membrane of the urethra, upon the pharynx, &c. and especially upon the uvula which is so sensible? why, instead of epispastics upon the perineum and sacrum, should we not introduce a sound into the urethra for a paralysis of the bladder? Instead of acting in hemiplegia upon the cutaneous organ, I have already twice employed the following means; I have introduced a sound into the urethra, one in each nasal fossa, and at the same time, a surgeon irritated at intervals the uvula; the patients appeared to be much more excited than by blisters. Very strong purgative enemas and emetics prove the advantage of the excitement of the mucous membranes in this case. Would it not often be better in ophthalmia, to produce an artificial catarrh in the nostril of the diseased side, than to put a blister or seton in the neck? I have once tried it; it did not succeed; but the ophthalmia was of long standing; I propose to repeat these experiments at the Hôtel Dieu upon a great number of patients. I think that we might often in diseases make use of mucous excitements instead of cutaneous, with much more advantage, because

in the mucous system the contact of a body is sufficient, and it is not necessary to produce, by removing the epidermis, a kind of ulcer.

The mucous membranes by the continual secretion of which they are the seat, enjoy a principal part in the animal economy. We ought to consider them as one of the great emunctories by which the residue of nutrition constantly escapes, and consequently as one of the principal agents of the habitual decomposition which removes from living bodies the particles that, having for some time contributed to the composition of the solids, are afterwards to become heterogeneous to them. Observe in fact that the mucous fluids do not enter the circulation, but go out of the body; that of the bladder, the ureters and the urethra, with the urine; that of the vesiculæ seminales and the different ducts with the semen; that of the nostrils by the act of blowing the nose; that of the mouth, in part by evaporation and in part by the anus with the excrements; that of the bronchia by pulmonary exhalation, which arises principally, as I shall say, from the solution of this mucous fluid in the inspired air; those of the œsophagus, the stomach, the intestines, the gall-bladder, &c. with the excrements, of which they often form in the ordinary state a part almost as considerable as the residue of the aliments, and which they even compose almost entirely in some cases of dysentery and fever, in which the quantity of matter voided is evidently disproportioned to that taken in, &c. Let us observe upon this subject that there are always some errors in the analyses of the fluids in contact with the membranes of which we are speaking, as in that of the urine, the bile, the gastric juices, &c. because it is very difficult and even impossible to separate the mucous fluids from them.

If we recollect what has been previously said upon the extent of the two general mucous surfaces, which is equal and even superior to the extent of the cutaneous organ,

and if we afterwards consider that these two great surfaces are constantly throwing out mucous fluids, we shall perceive how important this evacuation must be in the economy, and of what mischief its derangement must become the source. It is undoubtedly to this law of nature which wishes to have every mucous fluid thrown out, that must be attributed, in part in the fœtus, the presence of the unctuous fluid of which the gall-bladder is full, the meconium which loads the intestines, &c. fluids which appear to be but a mass of mucous juices, which being unable to pass off, remain until birth, without being absorbed, upon the respective organs on which they have been secreted.

The mucous fluids are not the only ones that are thrown out, and are in this way excrementitious substances to the economy; this is the case with almost all the fluids separated from the mass of blood by secretion; this is evident as it respects the greatest part of the bile; probably the saliva, the pancreatic juice and the tears are also thrown out with the excrements, and their colour alone prevents them from being distinguished like the bile. I do not even know if, by reflecting on many phenomena, we might not attempt to establish as a general principle, that every fluid separated by secretion does not enter the circulation again, that this phenomenon belongs only to the fluids separated by exhalation, as those of the serous cavities, of the articulations, of the cellular texture, of the medullary organ, &c.; that all the fluids are thus either excrementitious or recrementitious, and that no one is excremento recrementitious as the common division implies. The bile in the gall-bladder, the urine in the bladder, the semen in the vesiculæ seminales, are certainly absorbed; but it is not the fluid itself which re-enters the circulation; it is only its most delicate parts, some of its principles which we do not exactly know, probably the serous and lymphatic part; this does not re-

semble the absorption of the pleura and other analogous membranes, in which the fluid re-enters the blood as it came out of it.

That which is certain on the subject of the excretion of the secreted fluids is, that I have never been able to produce absorption of the bile by the lymphatics by injecting it into the cellular texture of an animal; it produces there inflammation and afterwards suppuration. We know that urine effused is not absorbed and that it destroys every part it touches, whilst that effusions of lymph and blood are easily discussed. There is as it respects the composition an essential difference between the blood and the secreted fluids. The exhaled fluids on the contrary, as the serum, in this respect resemble it very much.

Another very evident proof that all the mucous fluids are designed to be thrown out, is, that when they have continued for some time in any quantity upon their respective surfaces, they create there a painful sensation of which nature relieves us by various means. Thus the cough, which is the constant result of an accumulation of mucus in the bronchia, serves to expel it; thus vomiting in gastric derangements answers the same purpose as it respects the mucous juices accumulated in the stomach, whose presence produces a weight and even pain, though the membranes be not affected. We cough at will, because it is the diaphragm and intercostals by which this function is performed; we do not seek in medicine for any means to excite it. But as we cannot vomit at will, and as the presence of mucous juices often by fatiguing the stomach, does not irritate it sufficiently to produce a contraction, art has recourse to various emetics. We know what a painful sensation of weight the continuance of mucus accumulated in the frontal, maxillary, sinuses, &c. occasions, when there is a catarrh of a portion of the pituitary membrane. The region of the bladder is for

the same reason, in catarrhs of this organ, the seat of a troublesome and even painful sensation.

In general, the sensation which arises from the presence of the mucous juices remaining too long and in too great quantity upon their respective surfaces, varies because, as we shall see, each part of the mucous system has its peculiar mode of sensibility; so that the pain is not the same in each, though produced by the same cause. I would only observe that this sensation does not resemble that which arises from the tearing or the acute irritation of our parts; it is an uneasy, inconvenient sensation, difficult to be borne. Every one knows that which arises from mucus accumulated in the nasal fossæ, when the nose has not been blown for a long time, that disagreeable one that accompanies gastric derangements, &c. Those who have a weakness of the lachrymal sac in which the tears, on account of this, accumulate during the night, wake up with a sensation of weight, of which they are relieved by evacuating the sac by pressure, if the puncta lachrymalia are open.

Blood Vessels.

The mucous membranes receive a very great number of vessels. The remarkable redness that distinguishes them would be sufficient to prove it, if injections did not demonstrate it; this redness is not everywhere uniform. It is almost nothing in the sinuses of the face, in the internal ear, of which the membranes are rather whitish, and which appear so especially, because their extreme delicacy allows the bone upon which they are applied to be seen very distinctly. In the bladder, in the great intestines, in the excretories, &c. this colour, though still very pale, is a little more evident; it becomes very much so in the stomach, the small intestines, the vagina and in the pituitary and palatine membranes. In the gall-blad-

der we cannot distinguish it, because the bile always covers the mucous surface in the dead body.

This colour depends upon a very extensive vascular network, the branches of which, after having passed through the mucous corion, and ramifying there, divide and spread ad infinitum on its surface, embracing the papillary body and covered only by the epidermis.

It is the superficial position of these vessels and consequently their want of support on one side, that exposes them frequently to ruptures from considerable shocks, as happens on the surface of the bronchia from a severe cough, on that of the ear and the nose from a violent blow on the head. We know that hemorrhage of the mucous system bordering on the brain, is a common accident from concussions and wounds of the head. Hence why the least gravel makes the ureters bleed; why one of the signs of stone in the bladder is the passing of blood; why a blunt sound carefully introduced is so often withdrawn bloody from the urethra; why the least effort made with instruments carried upon polypi, into a fistula lachrymalis or into the nostrils, produces hemorrhage. I have already observed that we must carefully distinguish these hemorrhages from those furnished by the exhalants, and which do not suppose any vascular rupture.

It is also the superficial position of the vessels of the mucous system, which makes its portions visible, as the red edge of the lips, the glans penis, &c. often serve to show us the state of the circulation. Thus in the different species of asphyxia, in submersion, strangulation, &c. these parts are remarkably livid, an effect of the passage of the venous blood, which has undergone no change from the want of respiration, into the extremities of the arterial system.

The long continued exposure of the mucous system to the air, often makes it lose the redness that characterizes

it, and it then assumes the appearance of the skin, as has been observed by Sabatier in treating of prolapsus of the womb and vagina, which, from this circumstance, have sometimes so misled some people, as to make them believe it a case of hermaphrodism.

An important question presents itself in the history of the vascular system of the mucous membranes, viz. whether this system admits more or less blood according to different circumstances. As the organs within which these membranes are spread, are almost all susceptible of contraction and dilatation, as we see in the stomach, the intestines, the bladder, &c. it has been thought that during the dilatation, the vessels being more expanded, receive more blood, and that during the contraction on the contrary, being folded up, as it were choaked, they admit but a small quantity of this fluid which then flows into the neighbouring organs. Chaussier has made an application of these principles to the stomach, whose circulation he has considered as being alternately inverse of that of the omentum, which receives during the vacuity of this organ, the blood which this when it is contracted cannot admit. An analogous use has also been attributed to the spleen since the time of Lieutaud. The following is what the inspection of animals opened during abstinence and at different periods of digestion, has shown me upon this point.

1st. During the fulness of the stomach the vessels are more apparent on the exterior of this viscus, than when it is empty. Within, the mucous surface is not more red, sometimes it has appeared to me to be less so. 2d. The omentum, less extended during the fulness of the stomach, exhibits nearly the same number of vessels, as long, but more tortuous, than when it is empty. If they contain less blood, the difference is hardly sensible. I would observe, that in order to distinguish this well, it is necessary to take care that in opening the animal, the

blood does not fall on the omentum which presents itself, and thus prevent its state from being ascertained. This is besides a necessary consequence of the arrangement of the vascular system of the stomach. In fact the great stomachic coronary being situated transversely between it and the omentum, and furnishing branches to each, it is evident that when the stomach is lodged between the layers of the omentum by separating these layers, and this by applying itself upon it becomes shorter; it is evident, I say, that the branches which it receives from the coronary cannot be equally applied to it also. In order to this, it would be necessary that they should go from one to the other without the intermediate trunk that cuts them at right angles; then, in distending, the stomach would separate them as it does the omentum, and would be lodged between them; whereas it pushes them before it with their common trunk, the stomachic coronary, and makes them fold. 3d. I am confident that there is no such constant relation between the size of the spleen and the emptiness or fulness of the stomach, and that these two circumstances coincide necessarily, and that if the first organ increases or diminishes under different circumstances, it is not always precisely the reverse of the stomach. I first made, like Lieutaud, experiments upon dogs to convince myself of it; but the inequality in the size and age of those that were brought to me, making me fear that I should not be able to compare their spleens correctly, I repeated them upon guinea-pigs of the same litter and size, and examined at the same time, some when the stomach was empty and others when it was full. I have almost always found the size of the spleen nearly equal, or at least the difference was not very sensible. Yet in other experiments, I have seen under various circumstances, inequalities in the size of the spleen and especially in the weight of this viscus; but it was indifferently during or after digestion.

It appears from all this, that if during the vacuity of the stomach, there is a reflux of blood towards the omentum and spleen, this reflux is less than it has been commonly said to be. Besides during this state of vacuity, the numerous folds of the mucous membrane of this viscus leaving it, as we have said above, almost as much surface and consequently as many vessels as during fulness, the blood can circulate in it almost as freely. It has no real obstacles but in the tortuous courses, and not in the obstruction, compression and choaking of these vessels by the contraction of the stomach ; now this obstacle is easily surmounted, or rather it is not one as I have proved in my Researches upon Death. As to the other hollow organs, it is difficult to examine the circulation of the neighbouring parts during their fulness and vacuity, as the vessels of these are not superficial as in the omentum, and as they themselves are not insulated like the spleen. We can only then, to decide the question, see the state of the mucous membranes on their internal face ; now this face has always appeared to me to be as red during the contraction as during the dilatation.

Besides I only give this as a fact without pretending to draw from it any consequence in opposition to the common opinion. It is possible in fact that though the quantity of blood may be nearly always the same, the rapidity of the circulation being increased, more of this fluid may consequently in a given time enter it when it is full ; which appears to be necessary to the greater secretion that then takes place of the mucous fluids, a secretion excited by the presence of the substances in contact with the surfaces of the same name. For example, there is no doubt that there is three or even four times as much mucus secreted in the urethra, when a sound fills it, as when it is empty ; now the blood must be in proportion.

The remarkable redness of the mucous system, the analogy of respiration in which the blood flows through

the mucous surface of the bronchia the well known experiment of a bladder filled with blood and immersed in oxygen, by which means the blood becomes red, have induced a belief that the blood being separated from the atmospheric air only by a thin pellicle or some of the mucous surfaces, as upon the pituitary, the palatine, the glans penis, &c. assumed there a redder colour, either from getting rid of a portion of its carbonic acid gas, or by combining with the oxygen of the air, and that these membranes thus performed functions accessory to those of the lungs. The experiments of Jurine upon the cutaneous organ, experiments adopted by many celebrated philosophers, seem to strengthen this conjecture.

I tried the following experiment to ascertain this fact. I drew through a wound made in the abdomen a portion of intestine which I tied at one point, I afterwards reduced it, keeping out a small portion only which I opened and by which I introduced atmospheric air, which filled the whole portion situated on this side of the ligature. I afterwards tied the intestine below the opening, and reduced the whole of it. At the end of an hour, the animal being opened, I compared the blood of the mesenteric veins which arose from the portion of intestine distended with air, with the blood of the other mesenteric veins arising from the rest of the canal. No difference of colour was manifest; the internal surface of the distended portion of the intestine was not of a more brilliant red. I thought I should obtain a more evident effect, by repeating with oxygen the same experiment upon another animal; but I perceived no greater variety in the colour of the blood. As upon the mucous membranes which are ordinarily in contact with the air, this fluid is constantly changing and is agitated by a perpetual motion, and as in the preceding experiment it remained stagnant, I attempted to produce the same effect in the intestines. I made two openings in the abdomen, and drew out at

each a portion of the intestinal canal; having opened these two portions, I fitted to one the tube of a bladder full of oxygen and to the other that of an empty bladder; I afterwards compressed the full bladder, so as to make the oxygen pass into the other, by going through this portion of intestine, left in the abdomen that the heat might support the circulation in it. The oxygen was thus many times sent from one bladder to another, taking its course through the intestine, which, on account of its contractility is more difficult than it at first seems to be. The abdomen being afterwards opened I found no difference between the venous blood returning from this portion of intestine, and that which flowed from the others. The superficial position of the mesenteric veins, covered only by a fine and transparent layer of peritoneum, their size, if the animal be rather large, render this sort of comparison very easy.

I perceive that we cannot infer from what takes place in the intestines, what happens in the pituitary, palatine membrane, &c. because though analogous, the organization may be different. We cannot here as in the intestines examine the venous blood returning from the part; but, 1st, if we consider that in animals who have respired oxygen for some time, we see the palatine and pituitary membranes more red; 2d, if we reflect that the lividity of the different parts of this membrane, in those destroyed by asphyxia by the carbonic acid gas, depends not on the immediate contact of this gas upon the membrane, but upon the passage of venous blood into the arterial system, as my experiments have, I think, demonstrated; 3d, if we remark finally that in these circumstances the contact of the air does not change, after death, the lividity which the venous blood gives to the mucous membranes, although the skin be then much more permeable to every kind of aeriform fluid; we shall see that it is at least necessary to suspend our judgment upon the colouring of

the blood in the mucous membranes, until further observations have decided the question.

The following experiment may also throw some light upon the subject. I have inflated the peritoneal cavity of several guinea-pigs with carbonic acid gas, with hydrogen, oxygen and atmospheric air, to see if I could effect through a serous membrane what I could not make succeed in a mucous; I have not, after these experiments, found any difference in the colour of the blood of the abdominal system; it was always the same as in the common guinea-pig which I killed for comparison.

I think however that I have remarked many times, both in frogs and animals with red and warm blood, such as cats and guinea-pigs, that the infiltration of oxygen into the cellular texture gives, at the end of some time, a much brighter colour to the blood, than that which this fluid exhibits in artificial emphysemas produced by carbonic acid gas, hydrogen and atmospheric air, in all which the colour of the blood scarcely differ at all from what is natural. But in other cases oxygen has had no influence upon the colour of the blood; so that notwithstanding having made many experiments upon this point, I am unable to give any general result. It appears that the tonic forces of the cellular texture and of the parietes of the vessels which are spread upon this texture, receive a very variable influence from the contact of the gases, and that according to the nature of this influence, the fibres crisping and contracting more or less, render these parts more or less permeable, either to the aeriform fluids that tend to escape from the blood in order to unite with that of the emphysema, or to this last fluid, if it tends to combine with the blood, which no doubt produces the varieties I have observed.

The red colour of the mucous system is analogous to that of the muscular system. It does not depend essentially on the blood circulating in the small arteries of this

system. It arises from the colouring portion of the blood combined with the mucous texture, especially in the deep part of the organs; for at the origin of the mucous surfaces, this colour appears to be principally owing to the blood in circulation; in fact asphyxia does not render so livid the deep mucous surfaces, as it does those which are superficial and in communication with the skin. The black blood arrives immediately to these by the last arteries, and tinges them as we see. In syncope in which the heart being affected no longer sends blood into the arteries, we know that this portion of the mucous system becomes instantly white.

Besides the red colour of the deeper portions, can, like that of the muscles, be removed by repeated washing and frequently changing the water. Yet the water in which they have been washed is not as red as that used for the muscles.

The instant a mucous surface is plunged into boiling water, however red it may be, as that of the intestines and the stomach, it instantly whitens. The action of the nitric, sulphuric and muriatic acids produces in it also a sudden whiteness.

This colour of the mucous surfaces acquires a remarkable intensity in inflammation. The redness becomes then extremely deep on account of the quantity of blood that is accumulated in the capillary system. It is particularly in dysentery that the internal surface of the intestines exhibits this phenomenon in a striking degree. I ought however to observe to those who open dead bodies, that they never should lose sight of the original tinge of the portion of the mucous system they examine, since each of the divisions of this system exhibits in its shades remarkable differences. If the membrane of the bladder, the rectum, &c. is found as red as that of the stomach in its natural state, then pronounce that there had been inflammation; if the redness of the sinuses

equals that which is natural to the bladder and the rectum, decide that inflammation had existed in them. There is, as I have said, a scale of colour for the mucous system. It is then essential to have an accurate knowledge of this scale, a type to which we can refer the inflammatory state in the examination of dead bodies.

Exhalants.

Does exhalation take place upon the mucous surfaces? The analogy of the skin seems to indicate it; for it is well proved that the sweat is not a transudation through the inorganic pores of the cutaneous surface, but a real transmission by vessels of a peculiar nature and continuous with the arterial system.

It appears at first that the pulmonary perspiration which takes place upon the mucous surface of the bronchia, which has so much relation with that of the skin, which increases and diminishes according as this diminishes or increases, and the matter of which is probably of the same nature; it appears, I say, that the pulmonary perspiration is made at least in great part by the system of exhalant vessels, and that if the combination of the oxygen of the air with the hydrogen of the blood contributes to produce it, during the act of respiration, it is but in very small quantity, and it is the portion that is purely aqueous. Besides, this last hypothesis of modern chemists, contradictory to the production of all the other fluids thrown out by the mucous surfaces, appears to me ill adapted to explain the formation of this. When the same phenomenon is produced in many places, and the explanation that is given of it is applicable only to one, we should be suspicious of this explanation.

It should be observed in regard to the pulmonary perspiration, that the solution of the mucous fluid which lubricates the bronchia, in the air constantly inspired and expired, furnishes a considerable portion of this vapour

which, insensible in summer, is very evident in winter, on account of the condensation of the air. The mucous juices are dissolved like every other fluid; for wherever there is atmospheric air, heat and moisture, there is evaporation. Here this evaporation is even a means which nature employs to rid herself, as I have said, of the mucous juices. If they are too abundant, as in a cold, then the quantity of air which serves as a vehicle to them, not increasing in proportion, it is necessary that there should be another mode of evacuation; this is expectoration which compensates for what the air cannot remove by solution.

The intestinal juice which Haller has especially considered, but which appears to be in much less quantity than he thought it, the œsophagean and gastric juices, particularly this last which has been supposed to be distinct from the mucous juices, are probably deposited by exhalation upon their respective mucous surfaces. But in general it is very difficult to distinguish with precision what belongs in these organs to the exhalant system, from that which is furnished by the system of mucous glands, which, as we have said, are everywhere subjacent to them. Thus we constantly see the mucous fluids of the œsophagus, the stomach and the intestines, mixing with the œsophagean, gastric and intestinal fluids.

As on the one hand the blood vessels ramify almost naked on the mucous surfaces, and as on the other these vessels are always the origin of the exhalants, it is evident, that these have but a short course to run to arrive at their surfaces; they are rather pores than distinct vessels. Hence why no doubt the blood has so great a tendency to escape by the exhalants; why consequently hemorrhages without rupture are so frequent in the mucous system; why this affection can be classed in the diseases of this system, &c. &c. No other, by the arrangement of the arteries, offers to the exhalants so short a

course between their origin and termination. Often even, as I have said, we make the blood of these vessels ooze in the dead body through their exhalants.

Absorbents.

The absorption of the mucous membranes is evidently proved, 1st, by those of chyle and of drinks on the intestinal surfaces, of the venereal virus upon the glans penis and the canal of the urethra, of the variolous when the gums are rubbed with it, of the serous portion of the bile, the urine and the semen, when they remain in their respective reservoirs. 2d. When, in the paralysis of the fleshy fibres that terminate the rectum, substances are accumulated at the extremity of this intestine, these substances often become hard, an effect probably of an absorption of the soft parts. 3d. There have been various cases in which the urine has been almost wholly absorbed by the mucous surface of the bladder, where there have been insurmountable obstacles in the urethra. 4th. If we respire, by means of a tube, the air of a large vessel filled with the exhalations of turpentine, so that these vapours can only act upon the mucous surface of the bronchia, the urine has the peculiar odour that always arises from the use of this substance, the exhalations from which have been introduced into the blood by the means of absorption, &c.

Whatever may be the mode of this absorption, it appears that it does not take place in a constant and uninterrupted manner, like those of the serous membranes, in which the exhalant and absorbent systems are in a regular and continual alternation of action. There is scarcely any but the chylous absorption, that of drinks, and that of the aqueous portion of the secreted fluids remaining in a reservoir as they come from their glands, that constantly take place. Nothing is more variable than the other absorptions. Under the same influence, the glans takes up

or leaves the venereal virus; the internal surface of the bronchia sometimes admits and sometimes refuses admittance to contagious miasmata. There are more cases of retention in which the urine is not absorbed entirely, than there are where this absorption takes place, &c. &c. The innumerable varieties of the vital forces of the mucous membranes, varieties produced by those of the stimuli with which they are in contact, explain these phenomena. If these forces are raised or diminished a little, the absorption is altered, even that which is natural, as that of the chyle. Take a purgative; it contracts, shuts even the mouth of the absorbents of the intestinal canal; as long as the irritation continues, all the drinks that are taken pass off by the anus; at the end of four or five hours, the absorbents gradually recover their natural tone and absorption recommences. In these cases, the first discharges are only the intestinal matters, the others are the copious drinks that have been taken. There are many diseases in which, the sensibility of the chylous absorbents being too much raised, they are no longer in relation with the aliments, they take up with difficulty the residue of them, &c. Deficiency of action produces the same phenomenon; in absorption in fact it is a middle degree of sensibility of the organ which produces it, a degree below or above which it cannot take place.

All the mucous absorbents appear to go to the thoracic duct.

Nerves.

I would remark that at all the origins of the mucous system, where the animal sensibility is very great and where it places us, like the skin, in relation with external bodies, cerebral nerves are distributed. The pituitary and palatine membranes, the conjunctiva, the mucous surface of the rectum, the glans penis, the prepuce, &c. exhibit this fact very evidently. There are hardly any nervous

filaments coming from the ganglions in these different places.

On the contrary, this last species of nerves is the predominant one in the intestines, in all the excretories, in the reservoirs of the secreted fluids, &c. places where the organic sensibility is the most evident.

ARTICLE THIRD.

PROPERTIES OF THE MUCOUS SYSTEM.

I. *Properties of Texture.*

Extensibility and contractility are much less in this system than they at first appear to be, on account of the numerous folds which it exhibits in the hollow organs during their contraction, folds which are developed only during extension, as we have seen. Yet these two properties become very evident in some cases. The excretories are capable of taking a size much larger than is natural to them. This is seen in the ureters in particular, which are sometimes found as large as an intestine. The ductus choledochus and the pancreatic duct have often also these dilatations. The urethra and the salivary ducts appear to be less extensible than the others. If they have ever so little obstacles from strictures, contractions, &c. they break rather than stretch; hence various urinary and salivary fistulas.

Hence there is, as we see, many varieties in the degrees of the extensibility of the mucous system; it is the same with regard to the contractility of texture. These two

properties are besides capable of being put rapidly into action. We know that the stomach, the intestines, the bladder, &c. pass in an instant from a great size to extreme contraction. Their functions even suppose this rapidity, without which they could not be performed. The palatine membrane which lines the cheeks, exhibits the same phenomenon when the mouth is filled with air, aliments, &c. which are afterwards expelled from it.

When the usual fluids cease to pass through the mucous ducts, they remain in permanent contraction; this is what takes place in the intestines below a preternatural anus. I have seen in this case the cæcum and the rectum reduced to the size of a large quill. Yet there is never then an obliteration of their parietes, on account of the presence of the mucous juices, of which the patient always passes a certain quantity. The urethra, after the operations for stone in which the urine passes for a long time through the wound, and in the great fistulas in the perineum or above the pubis, the salivary ducts in wounds which affect them and through which the whole saliva is discharged, the nasal canal in fistulæ lachrymales, contract also more or less, but are never obliterated. We know that the vas deferens is often a very long time without having semen pass through it, and yet it remains open. This phenomenon distinguishes the mucous ducts from the arterial, which, when the course of blood is interrupted in them, change into ligaments in which every thing like a canal disappears. We ought not to lose sight of this phenomenon of all the mucous ducts; it proves the incorrectness of the practice of those who, thinking that at the end of some time it is impossible to re-establish, in fistulas, the natural way, think it necessary to make an artificial one.

The mucous tubes are not only not obliterated when they are empty, but when inflamed they do not even contract adhesions of their parietes, as so often happens in the serous cavities, in the cellular texture, &c. Observe

how important this fact is to the great functions of life; what would indeed become of these functions, if in catarrhs of the intestines, the bladder, the stomach, the œsophagus, the excretories, &c. these adhesions were as frequent as they are in pleurisy, peritonitis, pericarditis, &c.

II. *Vital Properties.*

Few systems live in a more active manner than this few exhibit the vital forces in a higher degree.

Properties of Animal Life.

Constantly in relation, like the integuments, with external bodies, the mucous surfaces have occasion for a sensibility which would enable the mind to perceive these relations, especially at the origin of these surfaces. Thus the animal sensibility is very much developed there. It is even superior in it in many places to that of the cutaneous organ, in which no sensation is as acute as those which take place on the pituitary membrane from odours, upon the palatine from tastes, upon the surface of the vagina, the urethra, the glans penis during coition. But without speaking of these exaggerations of sensibility, if I may so express myself, all the natural phenomena of the mucous surfaces prove this property in an evident manner; it is unnecessary however to pause for these phenomena.

I would only observe that this sensibility, like that of the cutaneous organ, is essentially subjected to the powerful influence of habit, which tending constantly to blunt the acuteness of the sensation of which they are the seat, brings equally to indifference the pain and the pleasure they make us experience, and of which it is the medium, as we know. 1st. I say that habit brings to indifference the painful sensations arising upon the mucous membranes. The presence of a sound in the urethra for the first time,

is distressing the first day, painful the second, inconvenient the third, and insensible the fourth. Pessaries introduced into the vagina, bougies into the rectum, tents fixed in the nasal fossæ, and a canula kept for a length of time in the nasal canal, exhibit in different degrees the same phenomena. It is upon this remark that is founded the possibility of the introduction of sounds into the wind-pipe to aid respiration, and into the œsophagus to produce an artificial deglutition. This law of habit can even transform into a pleasure an impression at first painful; the use of snuff for the pituitary membrane and different aliments for the palatine, furnish well known examples of this. 2d. I say that habit brings to indifference agreeable sensations arising on the mucous surfaces; the perfumer, placed in an odoriferous atmosphere, the cook, whose palate is constantly affected by delicious tastes, do not find in their professions the acute enjoyments they give to others. From habit can even arise the succession from pleasure to painful sensations, as in the preceding case it converts pain to pleasure.

I would however observe that this remarkable influence of habit is only exerted upon sensations produced by simple contact, and not upon those produced by real injuries, as the tearing, the forced stretching, the cutting or pinching of the mucous system; thus it does not mitigate the pains caused in the bladder by pressure and by the tearing a stone occasions, or on the surface of the womb, of the nasal fossæ, &c. by a polypus, on that of the œsophagus or the wind-pipe by a sharp and uneven body accidentally lodged there, &c. &c.

It is to this power of habit over the sensibility of the mucous system, that must be in part referred the gradual diminution of its functions, which accompanies age. Every thing is stimulant in infancy, every thing is blunted in old age. In one, the very active sensibility of the alimentary, biliary, urinary, salivary surfaces, &c. con-

tributes principally to produce that rapidity with which the digestive and secretory phenomena succeed each other; in the other, this sensibility blunted by habitual contact, connects but slowly the same phenomena.

Is it not from the same cause that arises this remarkable modification of the sensibility of this system, viz. that at its origins, as upon the pituitary, the palatine membranes, the œsophagus, the glans penis, the opening of the rectum, &c. it gives us the sensation of the bodies with which it is in contact, and that it does not give this sensation in the very deep organs which it lines, as in the intestines, the excretories, the gall-bladder, &c.? In the interior of the organs, this contact is always uniform; the bladder only knows the contact of the urine, the gall-bladder that of the bile, the stomach that of the aliments masticated and reduced, whatever may be their diversity, to an uniform, pulpy mass. This uniformity of sensation produces no perception, because in order to perceive, it is necessary to compare, and here the two terms of comparison are wanting. Thus the fœtus has no sensation of the waters of the amnios; thus, the air, very irritating to a new born infant, becomes insensible to it. On the contrary, at the beginning of the mucous membranes, the stimulants vary every instant; the mind can then perceive the presence of them, because it can establish approximations between their different modes of action. What I say is so true, that if in the interior of the organs, the mucous membranes are in contact with a foreign body, different from that which they are accustomed to, they transmit the sensation of it to the mind. A catheter in the bladder, sounds introduced into the stomach, &c. are examples of this. Fresh air, in great heat of the atmosphere, suddenly introduced into the trachea, carries an agreeable sensation over the whole surface of the bronchia; but habit soon renders us insensible to it

and we cease to have the perception of it. Yet it is to be observed that when the intestines come out in preternatural inversions of the anus, their sensibility never becomes so acute as that of the palatine, pituitary surfaces, &c. &c. The absence of cerebral nerves no doubt has an influence upon this phenomenon.

The sensibility of the mucous system is much raised in inflammations; acute catarrhs are, as we know, very painful. The contact of bodies is then not only felt, but is very disagreeable. I would observe however that the sensibility never rises so high as it does in the inflamed cellular, serous, fibrous systems, &c. A phlegmon, a pleurisy, &c. compared with a catarrh, are sufficient to convince us of this. We may say that the organs least accustomed to feel in the natural state, experience in diseases the most acute sensations.

There is no animal contractility in the mucous system.

Properties of Organic Life.

Organic sensibility and insensible contractility are very evident in the mucous system. They are constantly put in action in it by four different causes; 1st, by the nutrition of this system; 2d, by the absorption that takes place in it, either naturally or accidentally; 3d, by its exhalation; 4th, by the constant secretion of its glands. These two properties are the original causes of all these functions, the increase and diminution of which are truly the indices of the state of these glands. As a thousand causes continually act upon the mucous surfaces, as a thousand different stimuli continually excite them, especially at their origin, this state is incessantly varying like the functions that result from it.

The mucous system differs then from most of the others; 1st, in this, that the organic sensibility and the insensible contractility are habitually more exalted in it,

on account of the more numerous functions over which they preside; 2d, in this, that they incessantly vary, on account of the variety of the stimuli. Observe in fact that, in the osseous, fibrous, cartilaginous, muscular, nervous systems, &c. on the one hand, these properties are put in action only by nutrition; and on the other, no stimulant being in contact with these systems, they always remain at the same degree.

Hence it is not astonishing that the diseases which especially put in action the organic sensibility and the insensible contractility of the same species, should be so frequent in the mucous organs. All the catarrhal affections, both acute and chronic, all the hemorrhages, various and numerous tumours, polypi, fungi, &c. all kinds of excoriations, ulcers, &c. of which they are the seat, are derived from the various alterations of which their organic properties are susceptible.

It is also to these alterations that must be attributed a remarkable phenomenon, viz. the innumerable varieties the mucous fluids exhibit in diseases. Take for example those that are thrown off from the internal surface of the bronchia, those that are brought up by expectoration, and which we can examine better than others, because they are mixed with no foreign substance; observe how they differ, in the different affections of the chest; sometimes they have a yellowish and as it were bilious tinge; sometimes they are frothy in the vessel which receives them; sometimes they adhere to it with tenacity, and at others they are easily detached from it. Viscid or liquid, fetid or without odour, grey, white, green or even black in the morning, they have a thousand external appearances which evidently denote differences in their composition, differences which chemists have not yet explained to us. I do not speak of the cases where as in phthisis, hemoptysis, &c. foreign substances are mixed with these mucous juices. Now it is evident that all these varieties depend

only upon the varieties of the organic sensibility of the bronchial glands or of the membrane upon which they pour out their fluids. According as the property is differently altered in the mucous system, it is in relation with different substances, admits some and rejects others. The same organ, the same vessels can there, according to the state of the forces that animate them, separate from the mass of blood many different substances, rejecting one to-day and admitting it to-morrow, &c.

Do you wish for other proofs of the innumerable varieties which the different modifications of the organic sensibility of the mucous membranes produce in their functions? Observe the urethra; in the ordinary state it lets the urine pass freely; in the excitement in which its forces are in erection, its sensibility repels it and admits only the semen. Who does not know that in one species of epiphora, the mucous passages for the tears are open, and that the diminution only of their vital forces prevents this fluid from flowing in them? The sensibility of the mucous surfaces is oftentimes so altered that their glands refuse to admit every kind of fluid; this happens in the beginning of some peripneumonies, in which expectoration is entirely suppressed, it is always a serious beginning, and even an indication of death, if the state of the sensibility does not change, unless a relaxation, as it is commonly called, takes place.

In general, I think that there are but few systems which deserve, more than this of which we are treating, to fix the attention of physicians, on account of the innumerable alterations of which it is susceptible, alterations which almost always suppose those of the predominant vital properties of this system, as the alterations of the muscular, nervous systems, &c. most often put in action the properties which more particularly belong to them, viz. animal contractility for one, and the sensibility of the same species for the other.

The sensible organic contractility does not appear to be the attribute of the mucous system; yet there is often in it something more than the insensible oscillations which compose the other organic contractility. For example, in the emission of semen, in which there is no agent of impulse at the extremity of the urethra, as in the evacuation of urine, it is very probable that this is spasmodically contracted to produce the jet, oftentimes very strong, which then takes place. The following phenomenon which I have observed in myself appears to belong to the same cause. In gaping, there sometimes escapes from the mouth then wide open, a small jet of fluid, which coming from the lateral parts of this cavity that it passes over, is thrown at some distance; if a surface is then before the mouth, as when we read a book, this fluid is spread in small drops upon this surface; it is the saliva which the excretory duct of Steno throws out with force. Now on the one hand this duct is almost wholly mucous, and on the other it has not at its posterior part a muscular agent of impulse. Perhaps the excretories which pour out their fluids in the deep parts of the organs, exhibit the same phenomenon. We know that the milk is also sometimes subject to a kind of ejection, when it is very abundant, an ejection which supposes a powerful contraction of the lactiferous ducts. In general, these different motions analogous to that of the dartos, of the cellular texture, &c. appear to hold a middle place between those of tone and those of irritability.

Sympathies.

There are few systems that sympathize more frequently with the others than this. Now in its sympathies, it sometimes influences and sometimes is influenced. The first Tissot calls the active mode of sympathy, the second the passive. Let us make use of this classification.

Active Sympathies.

One point of the mucous system being inflamed, irritated or stimulated in any way, all the vital forces can enter separately into action in the other systems.

Sometimes it is the animal contractility that is brought sympathetically into action ; thus the diaphragm, the intercostal and abdominal muscles contract to produce sneezing from irritation of the pituitary membrane, or cough from the irritation of the membrane of the bronchia, or from that even of the surface of the stomach, which produces stomachic coughs, which, as we know, have nothing to do with affections of the chest. We know the general spasm that seizes all the muscles the instant a foreign body passes between the mucous edges of the epiglottis. Stones of the bladder and the urethra, by making the cremaster contract sympathetically, produce retraction of the testicle. Physicians might, I think, profit by the knowledge of these mucous sympathies. In apoplexy, in which the bronchia is sometimes filled with mucus that the patient cannot evacuate, the action of ammonia upon the pituitary membrane produces the double effect, 1st, of stimulating the brain as blisters do ; 2d, of freeing, by the cough it occasions, the surface of the bronchia, which being obstructed, is an obstacle to the passage of the air.

Sometimes it is the animal sensibility that is put into action by an affection of the mucous surfaces. The stone, that irritates that of the bladder, causes an itching at the end of the glans penis. That of the intestines being irritated by worms, an inconvenient itching is felt at the end of the nose. Whytt has seen a foreign body introduced into the ear, affect painfully the whole corresponding side of the head ; an ulcer of the bladder, produce every time the patient passed water, a pain on the superior part of the thigh, &c. &c.

The sensible organic contractility is often sympathetically excited by the affections of the mucous system. I might at first refer to this subject what I have observed respecting the organic muscles, almost all of which move from an excitement of a contiguous mucous surface; but that is a natural phenomenon; there are many others that are preternatural. A stone that irritates the internal surface of the pelvis of the kidney produces vomiting, which is, as we know, produced any time at will by an irritation of the uvula. The instant the semen passes the urethra in coition, the action of the heart is commonly accelerated. Tissot speaks of a stone which, being entangled in the duct of Warton, produced a sympathetic discharge from the bowels. I saw at the Hôtel Dieu two women, who, whenever they menstruated, and the mucous surface of the womb was consequently in activity, could retain the urine but a short time in the bladder, which contracted involuntarily to expel it the moment it entered it. At ordinary times, there was nothing peculiar in the evacuation of this fluid.

As to the sympathies of insensible contractility and of organic sensibility, they take place when a mucous surface being irritated towards the extremity of an excretory duct, the gland of this duct is brought into action, when, for example, the saliva flows in greater abundance by the action of sialagogues upon the extremity of the Stenonian duct. Whenever there is a gastric derangement and the mucous surface of the stomach consequently suffers, the surface of the tongue is sympathetically affected; the glands situated under this surface increase their action and hence that white mucous coat, that is commonly called a foul tongue, which is a real sympathetic catarrh, but which can however exist idiopathically. Here also is to be referred the remarkable influence of the mucous system upon the cutaneous; thus during digestion, in which the mucous juices pour out abundantly from all sides into

the stomach and the intestines, and in which the mucous membranes of the gastric viscera are consequently in great action, the fluid of insensible transpiration is lessened remarkably, according to the observation of Sanctorius; it is in very small quantity three hours after the meal, so that the action of the cutaneous organ is evidently less energetic. Thus during sleep, in which all the internal functions become more evident and are exerted to their utmost, and in which the sensibility of the mucous membranes is consequently strongly developed, the skin seems to be struck with a species of atony; it becomes cold more easily, it allows less substances to escape from it, &c. To these sympathies also can be referred many phenomena of hemorrhages. We know with what facility the mucous surface ceasing, from any accidental cause, to throw out blood, as happens so often on that of the womb, another is immediately affected and discharges this fluid; hence hemorrhages from the nose, the stomach, the chest, &c. from the suppression of those of the uterus, &c.

Passive Sympathies.

In many cases, the other systems being irritated, the animal sensibility of this is brought into action. Among the numerous examples of this fact, the following is a remarkable one. In many diseases in which organs foreign to the mucous system are affected, we experience a sensation of burning heat in the mouth, the stomach, the intestines, &c. and yet the mucous surface, the seat of this sensation, does not disengage more caloric than usual; we may be convinced of this by placing the fingers in the mouth. This sensation is of the same nature as that which we refer to the glans penis when there is a stone in the bladder, as that which is experienced at the end of the nose from worms in the intestines, &c. There is no material cause of pain, and yet there is suffering. Thus in intermittent fevers we experience a cutaneous shiver-

ing, though the skin may be as warm as usual ; I would observe in respect to this, that the mucous membranes are hardly ever the seat of an analogous sensation of sympathetic cold, but it is almost always a sensation of heat that the aberrations of the vital forces produce in them. Whence arises this difference between them and the cutaneous organs? I know not. I attribute also to a sympathy of animal sensibility the great thirst which takes place in all the severe affections of any part. In all great wounds, after severe operations, in experiments on living animals, &c. we observe this thirst which depends upon a sympathetic affection of the whole mucous surface that extends into the mouth, the stomach and the œsophagus.

Animal contractility cannot be put sympathetically into action in the mucous system, since it does not exist in it.

The same is true of the sensible organic contractility. It is possible that sometimes the kind of motion we have noticed, and which resembles this property, may be sympathetically excited; I know no example of it.

The insensible organic contractility is here very frequently in sympathetic activity. It is the skin especially which exercises by means of this property, a great influence upon the mucous system. 1st. In hemorrhages of the mucous surface of the womb, the nostrils, &c. a cold body applied to the skin in the neighbourhood, contracts this surface and stops the blood. 2d. Who does not know that the production of most catarrhs is often the sudden consequence of the action of cold on the cutaneous organ? 3d. In various affections of the mucous membranes, baths which relax and expand the skin, frequently produce happy effects. 4th. When the temperature of the atmosphere benumbs the cutaneous tone, that of the mucous system receives a remarkable increase of

energy. Hence why in winter and in cold climates, in which the functions of the skin are very much diminished, all those of this system increase in proportion. Hence the more evident pulmonary exhalation, the more abundant internal secretions, a more active digestion, more quickly performed and consequently an appetite more easily excited. 5th. When on the contrary the heat of the climate and the season relax and expand the cutaneous surface, the mucous surface is in proportion contracted; in summer, at noon, &c. there is a diminution of the secretions, of that of the urine especially, a slowness in the digestive phenomena from a defect in the action of the stomach and intestines, an appetite slow to return, &c. 6th. In various general affections of the skin, certain portions of the mucous membranes are almost always affected. In scarlet fever, the throat most usually suffers sympathetically. This phenomenon is very common in small pox. 7th. In the latter periods of organic affections of the viscera, as in phthisis, diseases of the heart, enlargements of the liver, cancers of the womb, &c. the mucous membranes are affected like the serous surfaces. The kind of atony in which they then are, produces a more copious flow of mucous juices in them which are altered, become more fluid, &c.; hence the diarrhœas that are called colliquative, which are then to the mucous surfaces, what dropsies are to the serous ones. 8th. It is also to this atony that must be attributed the pectoral hemorrhages which so frequently take place in the last periods of organic diseases, in those of the heart especially. During the short time that I have been at the Hôtel Dieu, there has already died more than twenty patients whom I have opened, of these affections almost forgotten by all practitioners before the time of Corvisart; I have only observed four examples in which passive hemorrhage of the lungs was not the precursor of death.

Character of the Vital Properties.

From what we have thus far said, it is evident that the mucous system is one of those of the whole economy, in which life is the most active. Always in contact with substances that stimulate and irritate it, it is as it were like the skin, in continual action. Yet the life is not the same in all its parts; it undergoes in each remarkable modifications, which no doubt depend on those we have pointed out in the organization of this system, in the nature of its corion, in the arrangement of its papillæ, in the distribution of its vessels and its nerves, in that of its glands, &c.; for as we have seen, none of these essential bases of the mucous system is everywhere arranged in the same manner. There is an organization common to the system, and one peculiar to each of its divisions. It is the same in regard to its life; there is a life common to the system, and as many peculiar ones as there are parts to which it is extended. We know how much the animal sensibility of the pituitary membrane differs from that of the palatine, how powerfully the membrane of the glans penis and the urethra is stimulated by the passage of the semen which makes no impression upon any other mucous surface. The same is true in regard to the organic sensibility and the contractility of the same species. Each mucous surface, in relation with the fluid it is accustomed to, would bear the others with difficulty. The urine would be a stimulant for the stomach and the gastric juice for the bladder; the bile that remains in the gall-bladder would produce a catarrh upon the membrane of the nose, in the vesiculæ seminales, &c.

From these varieties in the vital forces of each division of the mucous system, it is not astonishing that the diseases of this system should also be very variable. Each has a general character, but this is modified in each mucous surface. There is an order of symptoms common

to all catarrhs; but each has its peculiar signs, each has its different products. The fluid from a pulmonary catarrh does not resemble that from a nasal one; that coming from a urethral, vesical catarrh, &c. is wholly different from that from an intestinal one. These fluids exhibit in their morbid changes the same differences that we have pointed out in their natural composition, differences which are derived like them, from the different vitality of each portion of the mucous system.

It is to these varieties of life and the vital forces that must be referred also those of the sympathies. Each portion of this system has a peculiar sympathetic action upon the other organs. The pituitary alone being irritated produces sneezing. You would excite in vain the extremity of the glans penis, the rectum, &c. you would never produce vomiting as you do by stimulating the uvula.

An important remark should here be made in regard to the stomach. We know that there is no organ which performs a more important part in the sympathies than this. The least affection of this important viscus, the least gastric derangement, spread over the whole animal economy a painful influence; all the other parts feel it. I do not believe even that there is any uneasiness more fatiguing and general than that which we then experience in certain cases. The general weakness which takes place in hunger almost instantaneously, is sympathetic; the alteration of nutrition has not had time to produce it. The same is true with regard to the sudden increase of the forces which results from the contact of the aliments upon the mucous surface of this viscus, an increase which cannot be attributed to the passage of the chyle into the blood, which has not yet had time to take place.

I think the stomach owes this important part in the sympathies principally to its mucous surface. In fact, 1st, its serous surface has no connexion with it, since it is

there of the same nature as in all the rest of the peritoneum, besides in what is called inflammation of the abdomen, and in which this serous surface is especially affected, we do not observe such numerous sympathetic relations. 2d. The fleshy coat appears to be the same as that of the whole intestinal canal; why then should it have different influences? 3d. As it respects blood-vessels and nerves of the ganglions, the stomach is nearly organized like the rest of the alimentary tube. 4th. It has besides the par vagum; but is this nerve alone capable of producing such numerous phenomena? It can contribute to them; but certainly the peculiar modifications which it experiences in the mucous surface, the peculiar nature of this membrane contribute also much to it. No membrane is organized like that of the stomach. Though we do not see perfectly at first view its organic differences, reflection is sufficient to convince us of them; thus on the one hand no one separates so great a quantity of fluid, and on the other none furnishes one of a nature analogous to that of the gastric juice.

ARTICLE FOURTH.

DEVELOPMENT OF THE MUCOUS SYSTEM.

I. *State of the Mucous System in the First Age.*

The development of the mucous system follows in general the laws of that of the organs to which it belongs. Early in the gastric apparatus, later in the pulmonary and

that of generation, it seems in its growth rather to obey the impulse it receives, than to give one to what surrounds it, an arrangement common to almost all the systems which contribute to form the different apparatus. Observe in fact that there is always in the growth certain parts to which all the others refer; thus in the cerebral apparatus, the early size of the brain produces that of the bones of the cranium, of the dura-mater, the pia-mater, the arachnoides and the vessels; thus it is on account of the spinal marrow, that the vertebral canal is so evident in the fœtus; thus all the serous surfaces have a growth in proportion to that of their respective organs, &c. &c. I would remark however that the early growth of the systems which are only to follow that of the parts to which they are destined, is only in the dimensions of length, breadth, &c. The thickness most commonly does not correspond with these dimensions. Thus the bones of the cranium though broader in proportion than those of the pelvis in the fœtus, are not thicker. The extent of the dura-mater is in proportion greater than that of the albuginea which belongs to the same system; but the organization is no further advanced.

In the fœtus, the delicacy of the mucous texture is extreme, the papillæ are hardly perceptible. But by carrying the hand over a mucous surface, we feel there an extremely delicate velvet and such as is not equalled by the finest velvet. The redness of this system is not then as evident, because no doubt less blood penetrates it, as the various functions which are afterwards to take place upon these surfaces, as digestion, the excretions, respiration, &c. are but feeble or entirely wanting. At this age, the quantity of blood seems to be in an inverse ratio in the skin and in these surfaces. The mucous red is then like the muscular, of a very deep tinge, often even livid, on account of the nature of the blood circulating in the arteries. Then the adhesions of the mucous texture to

the subjacent cellular are less; those especially of this last with the surrounding parts are very slight; thus it is very easy to draw out whole the internal portion of the intestines of the fœtus, from the external covering that contains it, so as to see two cylindrical canals, one of which is muscular and serous, the other cellular and mucous. The stretching destroys in this experiment all the valvulæ conniventes, and the small intestines are as smooth on the interior as the large, in the canal artificially extracted. If we subject this canal to ebullition, much more scum arises from it than in the adult; this scum is white and never green. The crisping that takes place a little before the first boiling, diminishes more in proportion the length of the canal, and consequently appears to be stronger.

At birth, when respiration and digestion suddenly commence, the secretions increase, the mucous system acquires a remarkable degree of activity. It is instantly excited powerfully by the many new substances with which it is in contact. It is by it and by the cutaneous system that bodies foreign to ours then immediately stimulate it, and so much the more efficaciously, as the double surface which receives the excitement is not accustomed to it. Then the red blood which penetrates the mucous system, gives it an increase of energy and sensibility, which renders it still more proper to receive impressions. Thus the mucous juices which till then stagnated upon their respective surfaces, without fatiguing and irritating them, are suddenly for them, on account of their increase of sensibility, stimulants which excite them, and force the subjacent muscles to contract. Then the urine becomes for the bladder a cause that promotes the contraction of it. A few instants after birth, all the openings in which the mucous membranes begin, open and permit to escape the meconium, the urine and all the mucous juices. This internal and general shock that empties all

the mucous cavities, renders them fit to become the seat of the great functions which are soon to take place in them.

When all the internal functions are in activity, the mucous surfaces experience no more sudden changes, analogous to that of which I have spoken. They grow like the other viscera in a slow and insensible manner; they preserve for a long time their original softness, which is remarkable, especially in the nose, the stomach, &c. and which during lactation, is not adapted in the infant, to the solid substances with which the adult is nourished. Is this softness the cause of the mucous affections which are in general so common at that age? We know that then the mucous juices abound; the pituitary membrane is more moist; the stomach and intestines are frequently affected with a species of catarrh which is the cause of the looseness that we have so often to combat in infancy. The membrane of the bronchia is also frequently diseased. The two extreme ages of life resemble each other by the abundance of the mucous juices secreted upon their respective mucous surfaces.

In youth the mucous system is in very powerful action. The active hemorrhages of this system are very frequent at this age; those of the nose, the bronchia and even the stomach often take place; those of the portions of this system, subjacent to the diaphragm, are then less common. Observe that in man, hemorrhages of the gastro-pulmonary surface are infinitely more frequent than those of the genito-urinary surface, which on the contrary, are much more numerous in woman in whom one of them is natural to a part of this surface, viz. menstruation.

At the period of puberty, the development of the genital parts in both sexes, gives much activity to a part of the genito-urinary surface; then menstruation begins upon that of the womb; then the sensibility of the urethra is raised in order to feel acutely the passage of

the semen. Observe that this increase of energy is not attended with a weakness of the other parts, as happens in many cases; on the contrary, all the systems, all the apparatus seem to borrow, from the force which the genital parts acquire, an increase of action.

II. *State of the Mucous System in the subsequent Ages.*

In the years which succeed youth, the mucous system continues to grow, thicken and become firmer. Its vital energy seems still to predominate for some time, in the superior surfaces, as in the pituitary, the membrane of the bronchia, &c.; thus the affections of these parts are more frequent until the thirtieth year. But as we advance in age, the abdominal mucous surfaces appear to predominate over the others, as in general all the organs of this region do.

Besides, a thousand causes in the course of life, make the state of the mucous system vary. We do not find it in two subjects, with the same shade of colour, with the same density, with the same external appearance. By taking any surface upon many subjects, that of the stomach, for example, we easily see these differences, with which we must be struck if we have opened dead bodies but ever so little.

The redness of the mucous texture is very bright until the thirtieth year; after that, it begins to alter. This texture becomes more and more pale in old age; the blood enters it but in small quantity; it acquires more consistence and density. The fingers carried over it no longer perceive that softness, that velvet so remarkable in the first age. Its forces, which grow languid, render difficult, in the excretories, the exit of the fluids which pass through these tubes to be thrown out. Yet the mucous glands still secrete their fluids in very great abundance.

Often even these fluids increase in proportion which constitutes the catarrhal affections, so common in old age. But these affections then have the same character as the functions of the whole system; secretion takes place slowly; the disease is always chronic; most often it terminates only with life.

The mucous absorption is, at this age, slow and difficult, like all the others; the various contagions are taken much less easily, either by the respiratory surfaces, or by the contact of contagious miasmata upon the neighbouring surfaces of the skin. The chyle slowly absorbed, makes the digestive periods longer.

SEROUS SYSTEM.

THIS system, the name of which I borrow, like that of the preceding, from the fluid that constantly lubricates one of its surfaces, is always like it arranged in the form of membranes, and never in fasciculi like the muscular system, or in round bodies like the glandular. It is formed by the peritoneum, the pleura, the pericardium, the arachnoides, the tunica vaginalis, &c. The term serous membrane will then be very often used to designate it. No one, I believe, before the publication of my Treatise on the Membranes, had considered in a general manner these organs, which perform a less important part in the functions than the mucous, but which in diseases are almost as frequently affected. Pinel, who has perceived the analogy of their inflammations, has taken this system as a character of one of the classes of his phlegmasiæ.

ARTICLE FIRST.

OF THE EXTENT, FORMS, AND FLUIDS OF THE SEROUS SYSTEM.

THE serous system occupies the exterior of most of the organs of which the mucous lines the interior; such are the stomach, the intestines, the bladder, the lungs,

&c. We see it around all those that are essential to life, as around the brain, the heart, all the gastric viscera, the testicles, the bladder, &c. It does not form, like the mucous system, a surface everywhere continuous upon the numerous organs on which it is spread. But it is always found insulated in its different divisions which never have any communication. The number of these divisions is somewhat considerable. By considering in one view all the different serous surfaces, we see that as a whole they exceed the mucous surfaces viewed also in a general manner. One consideration is sufficient to convince us of it. The mucous and serous surfaces accompany each other in a very great number of parts, as in the stomach, the intestines, the lungs, the bladder, the gall-bladder, &c. so as to exhibit in them nearly the same extent. But on the one hand, the mucous surfaces extend where the serous are not met with, as in the nasal fossæ, the œsophagus, the mouth, &c. &c.; and on the other, there is a very great number of serous surfaces existing separately from the mucous, as the pericardium, the arachnoides, &c. Now if we compare the extent of the separate serous surfaces, with that of the separate mucous surfaces, we shall see that the first is much greater than the other.

These considerations, apparently minute, deserve however particular attention, on account of the relation of functions existing between these two surfaces taken as a whole, a relation which is especially connected with the exhalation of the albuminous fluids produced by one, and with the secretion of the mucous fluids, of which the other is the seat. Besides, in examining the extent of each serous membrane in particular, we see great varieties from the peritoneum which has the greatest surface, to the tunica vaginalis which has the least.

The serous surface taken as a whole, compared with the cutaneous surface, is also evidently superior to it in

extent; so that in this respect, the quantity of albuminous fluids constantly exhaled within, appears to be much more considerable than that of the fluid which is incessantly thrown off by insensible transpiration; I say in this respect, for different circumstances, by increasing the action of the cutaneous organ, can re-establish the equilibrium in the exhalation of these two fluids, one of which re-enters by absorption into the circulation, and the other is wholly excrementitious. I do not know even if the pulmonary and cutaneous exhalations united are not less than those which take place upon the serous surfaces.

Every serous membrane represents a sac without an opening, spread upon the respective organs that it embraces, and which are sometimes very numerous, as in the case of the peritoneum, sometimes single, as in the case of the pericardium, covering these organs so that they are not contained in its cavity, and so that if it was possible to dissect them from their surface, we should have this cavity whole. This sac has in this respect the same arrangement as those night caps, which are folded within themselves; a trifling comparison, but which gives an accurate idea of this sort of membranes.

From this general arrangement, it is easy to understand that the serous membranes are never opened to permit the vessels and nerves to penetrate the respective organs to which they go or from which they come off, but that they always wind round them and accompany them to the organ, and thus form for them a sheath which prevents them from being contained in their cavities; this removes the danger of infiltration of serum which lubricates them, an infiltration which would take place through the neighbouring cellular texture, especially if they were dropsical; if, as in the fibrous membranes, they were pierced with foramina for the passage of these vessels and nerves. This arrangement, exclusively remarkable in the membranes of which we are treating, and in

the synovial ones, is evident at the entrance of the vessels of the lungs, the spleen, the intestines, the stomach, the testicles, &c. We see it very well in the arachnoides, a membrane essentially serous, as I have demonstrated elsewhere.

From the general idea that we have given of these membranes, it is also easy to understand how almost all are composed of two distinct parts, though continuous, and embracing, the one the internal surface of the cavity where they are found, the other the organs of this cavity; thus there is a costal and pulmonary pleura, a cranial and cerebral arachnoides, one portion of peritoneum spread upon the gastric organs, and another upon the abdominal parietes, a free portion of the pericardium, and one adhering to the heart. The same arrangement exists in the testicles, &c.

Though the serous membranes may be separate, yet there sometimes exists communications between them; that for example of the cavity of the omentum with that of the peritoneum, that of the cavity of the arachnoides with the cavity of the membrane which lines the ventricles by the canal that I have discovered, and the external orifice of which is seen below and at the posterior part of the corpus callosum; whilst the internal one is seen above the pineal gland, between the two rows of small round bodies which are usually found in this place.

There is but one example of continuity between the serous and mucous membranes, that which exists, by means of the Fallopian tube, between the peritoneum and the uterine surface. How does the respective nature of the two membranes change here?

Free Surface of the Serous Membranes.

Every serous membrane has one of its two surfaces free, everywhere contiguous to itself, and the other adhering to the neighbouring organs. The first is remarkable

for its polish, which especially distinguishes this system and the following, from all the other membranes. All the organs which exhibit this arrangement owe it to the covering they borrow from it. The liver ceases to be smooth and shining at its diaphragmatic edge where the peritoneum abandons it. There is in this respect a great difference in the appearance of the anterior and posterior face of the cæcum. The bladder is rough wherever the peritoneal covering is wanting. The cartilages of the ribs have not the polish of those of the articulations which the synovial membrane covers.

Does this remarkable attribute of the serous membranes depend on the compression exerted upon them? Their situation in places where they are exposed to continual friction, would seem to make it probable. Bordeu thought so, when he said that all the parts of the abdomen are originally covered with cellular texture, which by pressure is afterwards changed into membranes; so that the peritoneum is formed partially upon each gastric organ, and its different parts give birth, by uniting, to the general membrane. This explanation of the formation of the peritoneum is applicable, according to him, to the pleura, the pericardium, and all the analogous membranes. But if this is the progress of nature, 1st, why, whatever be the period at which we examine the fœtus, do we find the peritoneum and the serous membranes as much developed in proportion, as their corresponding organs? 2d. How are the numerous folds of these membranes formed, such as the mesentery, the omentum, &c.? 3d. Why are there parts where they do not exist though they are exposed to as great friction as that of the parts where they are found? Why, for example, are the sides of the bladder destitute of it, whilst it covers its superior part? 4th. Why does it not also form serous surfaces around the great vessels of the arm, the thigh, &c. which impart to the neighbouring organs an evident motion? 5th. Why

does not the thickness of the serous membranes increase where the motion is strongest and diminish where it is weakest? Why for example does the thickness of the tunica vaginalis equal that of the pericardium? 6th. How can friction internally produce an organized body, whilst externally it constantly disorganizes the epidermis? 7th. How can we associate the vascular lymphatic texture of the serous membranes with the pressure that produces them? The impossibility of resolving these numerous questions proves, that it is not to mechanical pressure that must be attributed the formation of the serous membranes and the polish of their surface; that their mode of origin is the same as that of the other organs; that they commence and are developed with them; that this polish is an evident result of their organization, as the mucous papillæ depend upon the texture of the surfaces to which they belong. What would be said of a system in which these papillæ should be attributed to the pressure of the aliments upon the stomach, of the urine on the bladder, the air on the pituitary membrane, &c.?

The free surface of the serous membranes separates entirely from the neighbouring organs those upon which these membranes are spread; so that they are to these organs real boundaries, barriers, if I may use the term, or integuments, if it should be preferred, very different however from those which are external. Observe in fact that all the principal viscera, the heart, the lungs, the brain, the gastric viscera, the testicles, &c. limited by their serous covering, suspended in the middle of the sac that it forms, only communicate with the adjacent parts where their vessels enter; everywhere else there is contiguity and not continuity.

This insulation of position coincides very well with the insulation of vitality which is remarked in all the organs, and especially in those that we have just noticed.

Each has its peculiar life, which is the result of a particular modification of its vital forces, a modification which necessarily establishes one in the circulation, nutrition and temperature. No part feels, is moved and nourished like another, unless it belongs to the same system. Each organ executes on a small scale the phenomena which take place on a large one in the economy; each takes from the circulation the aliment that is proper for it, digests it, throws back into the mass of blood, the portion which is heterogeneous to it, and appropriates to itself that which can nourish it; it is digestion in miniature. No doubt the ancients wished to give an idea of this truth which has been so well explained by Bordeu, when they said that the womb was a living animal within another. A very important use then of the serous membranes is to contribute, by rendering independent the position of their respective organs, to the independence of the vital forces, life and functions of these organs.

Let us not forget to consider under the same point of view, the moist atmosphere with which they are constantly surrounded, an atmosphere analogous to that which the cellular texture forms for various other organs. In this atmosphere all the morbific emanations of the organ go and are lost, if we may so say, without these emanations injuring the other organs. We have seen that this atmosphere in the cellular system is sometimes the seat of phenomena wholly different, and serves to transmit diseases from one organ to another. Now the serous membranes are a barrier much less easily surmounted, because they have not filaments which go from one organ to another, there is only contiguity as I have said, with the organs that they surround. We very rarely see in the abdomen a disease of the liver communicated to the intestines, one of the spleen passing to the stomach, &c.

The smoothness of the free surface of the serous system greatly facilitates the motions of the organs which it

covers. We have already observed that nature employs two principal means for this object, viz. the membranes and the cellular texture. By distributing externally the second of these means, it has designed the first especially for internal motions. The smoothness and moisture of the serous surfaces are singularly favourable for them. These internal motions are usually regarded only in an insulated manner, as relating to the functions of the organ that executes them, as in relation to the circulation for the heart, respiration for the lungs, digestion for the stomach, &c. But they should also be considered in a general manner; they should be regarded as carrying through the whole machine a continual excitement which supports and animates the forces and the action of all the organs of the head, the chest and the abdomen, which receive less sensibly than the organs of the extremities, the influence of external motions. It is these internal motions that excite, sustain, and develop within, the nutritive phenomena, as the motions of the thigh, the arm, &c. without, favour the nutrition of the muscles which are found there; this is seen very evidently in bakers and other mechanics who exert more particularly this or that part. It is thus that the serous membranes contribute indirectly to the nutrition and growth of their respective viscera; but they never have a direct influence upon this nutrition, because their organization and life are different from the life and organization of these viscera.

The free surface of the serous system differs essentially from that of the mucous, in this, that it contracts frequent adhesions. The pleura is of all the serous organs, that in which these adhesions are the most evident. We find almost as many dead bodies in which they exist, as we do those in which they do not. Next to the pleura is the peritoneum, then the pericardium, then the tunica vaginalis, then the arachnoides, which is that of all the serous surfaces in which adhesions are the least frequent,

though I have observed them in it. These adhesions exhibit many varieties which can be studied best on the pleura, which are as follows.

1st. Sometimes the costal and pulmonary portion are so identified at many points or in every part, that they make but a single membrane, and are united as closely as the two edges of the lip in a hare-lip that has been operated upon with success. 2d. At other times the adhesion is so slight, that the least effort is sufficient to destroy it. I have many times noticed this fact in the pericardium. I saw it once in the tunica vaginalis of a man who had been operated upon for hydrocele by means of injection, at the time I was surgeon for operations at the Hôtel Dieu. Separated then from each other, the two surfaces were uneven; they lost their polish. 3d. Frequently between the costal and pulmonary portion of the pleura, between the surfaces of the peritoneum, &c. there are several elongations of various lengths, which form a kind of loose bridles, traversing the serous cavity, having the same organization and polish as the membrane of which they appear a kind of fold, containing in their interior a species of small canal, because they are formed by two layers united together, resembling very much the elongation of the synovial membrane of the knee, which goes from the posterior part of the patella to the space between the condyles of the femur, having also an appearance analogous to the different natural folds of the peritoneum. We can hardly conceive that these filaments so regularly organized can result from inflammation. I am inclined to believe that they are owing to an original conformation. 4th. Frequently between the two portions of the pleura, there are seen many other elongations wholly different, which are not smooth, and do not form canals, but which appear to be flocculent and really analogous to the cellular layers; so that where they exist it may be said, that the membrane is entirely changed into this tex-

ture, which is besides, as we shall see, the essential base of its organization. 5th. I do not speak of the adhesions produced by false membranes, by albuminous flakes, intermediate to the two portions of a serous surface, &c. These adhesions are to a certain point foreign to these surfaces.

II. *Adherent Surface of the Serous System.*

The external surface of the serous membranes adheres almost everywhere to the neighbouring organs; it is rare in fact to see these membranes detached on both sides. The arachnoides at the basis of the cranium, and some other examples are exceptions. This adhesion of the serous membranes to their respective organs, is wholly different from that of the fibrous membranes. In this last, the passage of the vessels so unites the two parts, that their organization seems to be common, and when one is removed, the other almost always dies, as is seen in the periosteum in relation to the bones, &c. On the contrary, every serous membrane is almost foreign to the organ it surrounds; their organization is different. The following are proofs of it;

1st. We very often see these membranes abandon and cover again successively their respective organs; thus the broad ligaments, at a great distance from the womb in the ordinary state, are to it like a serous membrane during pregnancy. An intestine when distended borrows from the mesentery a covering that quits it when it contracts. The omentum is by turns, as Chaussier has well observed, a loose membrane in the abdomen and a covering of the stomach. The peritoneal envelope of the bladder often leaves it almost entirely. Has not the hernial sac of those enormous tumours of gastric viscera originally served to line the parietes of the abdomen? Now it is evident, since the different organs can exist separate from their serous membranes, that there is no

connexion between their organization. 2d. It is always a loose texture, easily stretched in every direction, that serves as a means of union, and never a sanguineous vascular system, as in most of the other adhesions. 3d. The affection of an organ is not a necessary consequence of that of its serous membrane, and reciprocally the organ is often affected and the membrane does not become diseased. For example, in the operation for hydrocele, the testicle remains almost always sound in the midst of the inflammation of its tunica vaginalis. The inflammation of the mucous membrane of the intestines is not a consequence of that of their peritoneal covering; and reciprocally in the various acute catarrhal affections of the organs with a mucous membrane within and a serous one without, this last is never found inflamed. In a word, the affections of the mucous membranes are everywhere very distinct from those of the serous, though most commonly both contribute to the formation of the same organ. It is evident that a line of demarcation so great in the affections supposes one of course in the organization. The life of the serous membranes then is entirely distinct from that of their corresponding organs.

Yet there are cases where these membranes do not present this loose adhesion, and where they become so united to the organs which they line, that frequently the most delicate scalpel cannot separate them. Observe the tunica vaginalis on the albuginea, the arachnoides on the duramater, and other membranes which form what I have called the sero-fibrous, &c.; such is the connexion of these different surfaces, that many have been mistaken to the present time for a single membrane. There is however no more identity in the organization, than where the serous membranes are more loosely attached to their respective organs, as is seen in the peritoneum, the pleura, &c. Diseases sometimes make this difference very evident. I have seen the arachnoides in a subject that had

been affected with a chronic inflammation, evidently thickened on the internal surface of the dura-mater, without this having experienced the slightest alteration; it was detached without difficulty and torn with great ease.

III. *Serous Fluids.*

Every serous membrane is moistened on its internal surface by a fluid almost the same as the serum of the blood. The exhaling orifices constantly pour it out and it is constantly taken up by the absorbents. Its quantity varies. A mere dew in the natural state, it is exhaled in vapour when the serous surfaces are laid bare and allow the air to dissolve it. It is in general more abundant in dead bodies than in the living, because on the one hand the transudation which the tonic forces prevent, then easily takes place from the destruction of these forces, and supplies the place of the vital exhalation, by transmitting mechanically by their weight, the fluids of the surrounding organs to the different serous cavities, and because on the other hand, this destruction of the tonic forces prevents every kind of absorption; hence the stagnation and accumulation of this fluid. We know to what an extent this increases in various dropsies, especially in that of the abdomen.

Does this quantity vary according to the different states of the organs which the serous membranes cover? It has been long said, that the synovia is exhaled in greater abundance in the motion of the articulations, than in their state of rest. I have no data on this point founded upon experiment; but I am certain that I have many times observed in living animals, that the exhalation of the serous surface of the abdomen does not increase during digestion, or at least if it is greater, absorption becomes more active, and thus the surface of the peritoneum is not more moist than at another time. I have opened the thorax of

many small guinea-pigs, after having first made them run a long time in the chamber in order to accelerate their respiration, and I have not observed greater moisture on the pleura. Yet it cannot be doubted, as we shall see, that the quantity of the serous fluids may be very variable in the different acute diseases; that the serous membranes exhale more or less of them, according to the manner in which they are sympathetically affected.

In the first periods of inflammations, in which the exhalants of the serous membranes are full of blood which is preternaturally introduced into them, the serum does not ooze in greater quantity from their free surface. Then as they are on the one hand very sensible, and very dry on the other, the motions of the organs that they cover are wonderfully painful. It is in these first periods that adhesions take place. If they are not formed either on account of the motion, or for other reasons, and if resolution of the inflammation does not take place, then happens to the serous surfaces what happens to a wound not united; they suppurate, but this suppuration is never attended with ulceration or erosion of their substance. However abundant the purulent collections may be, these membranes always remain sound; their texture is only more or less thickened; pus is thrown out by them, like the natural serous fluids, that is by exhalation. We know how much this fluid varies in consistence from milky serum, to the thickest false membrane that adheres strongly to the surface that has exhaled the materials of it.

The nature of the fluids of the serous system is very evidently albuminous. The instant one of the membranes of this system is plunged into boiling water, I have observed that it is covered with a white layer which is concrete albumen, and which being removed some time after, leaves the surface nearly of its original colour. All the substances which coagulate albumen produce a similar layer upon the serous surfaces. The ex-

periments of Hewson, who has collected some spoonsful of these fluids in the great animals, confirm their albuminous nature. Rouelle and Fourcroy who have analyzed the water of dropsies have also found albumen predominant in it. Observe upon this subject that all the white flakes swimming in this water, that the false membranes that form in it and the white fluids which give it the appearance of milk, appear to be only albumen which is found in different degrees of consistence. It might be said that the heat of inflammation has produced the same phenomenon during life, that common caloric does upon the white of an egg, the water of dropsies, &c. I shall not treat of the other accessory principles that enter into the composition of the serous fluids.

ARTICLE SECOND.

ORGANIZATION OF THE SEROUS SYSTEM.

The first characters of the structure of these membranes are a white, shining colour, less brilliant than that of the aponeuroses; a variable thickness, very evident upon the liver, the heart, the intestines, &c. hardly discoverable upon the arachnoides, the omentum, &c.; a remarkable transparency whenever these membranes are raised for a considerable extent, or are examined where they are detached on both sides, as on the omentum.

All have but a single layer which it is possible, at the places where it is thick, to raise from the cellular layers, but which can never be neatly divided into two or three portions; a character essentially distinct from those of the mucous membranes. The action of a blister on their

external surface first laid bare, for example, on a portion of intestine drawn out in a living animal, does not make a pellicle rise upon it, as upon the skin, a pellicle under which the serum is collected. I have frequently made this attempt. What is the immediate structure of this single layer of the serous membranes? I shall now examine it.

I. *Cellular Nature of the Serous Texture.*

Every system is in general, as we have thus far seen, an assemblage, 1st, of common parts, which are especially the cellular texture, the blood vessels, the exhalants, the absorbents and the nerves, which form as we have said the outline and the frame of it, if I may so express myself; 2d, of a peculiar fibre formed by a substance which is deposited in this outline, by gelatine, for example, for the cartilages, by gelatine and phosphate of lime for the bones, by fibrin for the muscles, &c. That which makes these organs resemble each other then is the cellular organ, the vessels and the nerves; that which distinguishes them, is their peculiar texture, which depends itself upon a peculiar nutritive matter. A bone would become a muscle, if, without changing its texture at all, nature had imparted to it the faculty of secreting fibrin, and of encrusting itself with it, instead of separating the phosphate of lime and being penetrated with it. But the serous system does not appear to have in it a distinct nutritive matter, and consequently a peculiar texture. It is only formed of the mould, the outline of others, and is not penetrated by a substance that characterizes it. Almost wholly cellular, it does not differ from this system in its common form, except by a degree of condensation, by an approximation and union of cells which are found scattered in the ordinary state.

The following are the proofs that the texture of the serous system is wholly cellular. 1st. There is an iden-

tity of nature where there is an identity of functions and diseases; now it is evident that the uses of these membranes and of the cellular texture, as it respects the continual absorption and exhalation of lymph are completely the same, and that the phenomena of the various dropsies are common to them, with the difference only of the effusion in the one and infiltration in the other. 2d. The inflation of air into the texture subjacent to these membranes terminates by bringing them almost to a cellular state, when it succeeds and is pushed for some time; an experiment which is frequently very difficult. 3d. Maceration, as has been remarked by Haller, produces at length the same effect, but in a still more evident manner. 4th. The various cysts, hydatids, &c. whose appearance, texture and nature even are entirely the same as in the serous membranes, as we have seen, always arise in the midst of the cellular texture, grow at its expense and are wholly formed of it. 5th. No fibre is found in the serous membranes; a character that distinguishes it from all the other organs and analogous to that of the cellular texture.

To these various proofs of analogy, of identity even of the cellular and serous systems, we can add the action of different reagents, which give results precisely similar in both. 1st. Every serous membrane when dried, becomes transparent, does not turn yellow like the fibrous and the mucous membranes, preserves a pliability foreign to these membranes when dried, and gradually resumes its original state when it is immersed in water. 2d. It becomes putrid much slower than the mucous surfaces, the muscular layers, the glands, &c. This is remarkable in the abdomen, upon the peritoneum which is frequently almost untouched, when every thing is putrid around it, as may be seen by removing it; for its transparency would make you believe at first view that it was altered, if you examine it upon the fleshy and mucous surfaces. 3d. Maceration at the ordinary temperature of cellars, re-

duces with great difficulty to a pulp the serous membranes. The omentum, the finest and most delicate of these membranes has resisted it for a very long time in my experiments. This phenomenon is particularly striking when compared with the maceration of tendons which are so resisting, and which support such great efforts during life. These become pulpy in water before the omentum is touched. The same phenomenon takes place with regard to all the other serous surfaces. 4th. In boiling water, these surfaces acquire the horny hardness like the fibrous system, but furnish infinitely less gelatine; they do not become yellow like it. The pleura in those portions of the thorax of animals that are brought to our tables, has almost its ordinary appearance; only it is less shining, has lost the faculty of crisping from the action of caloric, is no longer affected in the same way by acids, &c. If it was of a fibrous nature it would have disappeared in gelatine, on account of its delicacy. I shall say the same of the external membrane of the spleen, the liver and the lungs. Compare these membranes, that are brought to our tables, when boiled with the intermuscular aponeuroses, the tendons, &c. you will see that it is impossible to confound, as has been done, all the white textures together, in regard to their nature.

If we compare the different effects of agents the most known upon the serous system, with those that we have observed upon the cellular system, we shall see that they are entirely the same; that these two systems are consequently analogous, and even identical.

The serous system when it putrefies in the open air does not become green like the skin, but is of a dull and very deep grey. During life, on the contrary, its blackness is very evident in gangrene which is sometimes the result of an acute inflammation, sometimes of those chronic inflammations, attended with many small white tubercles, which are so frequently found upon these membranes.

This difference arises from the circumstance, that in the dead body these surfaces are not penetrated with blood at the time they become putrid ; whereas they contain much during life, when putrefaction succeeds inflammation which has filled the exhalants with it. Many other facts prove, that the greater the quantity of blood there is in a part when it putrefies, the more livid and black it becomes. In the many dead bodies that I have opened, I have never yet observed gangrene except in the peritoneum. I have never seen it in the pleura, the arachnoides, the pericardium, the tunica vaginalis; it no doubt takes place in them ; but I think I have opened dead bodies enough to allow my observation to establish as a general principle, that the peritoneum is more subject to it than all the other analogous organs.

Though the different considerations offered above establish much analogy between the cellular and the serous systems, they exhibit however real differences. First their external appearance is not the same. Then there is something in their intimate nature that we are unacquainted with, and which differs also; for whenever two organs are identical in their nature, they are subject to the same affections; now there is a disease of the serous surfaces that is not seen in the cellular system; it is those slow inflammations of which I spoke just now, a disease which should not be ranked in the class of the phlegmasiæ, and which the production of the small tubercles that attend it, especially characterizes. Authors who have not sufficiently attended to it, have denominated it chronic enteritis in the peritoneum, latent inflammation in the pleura, &c. though however foreign to every subjacent organ, except in the latter periods when it is propagated by the cellular texture, it has its seat exclusively in the serous membranes, and is an affection peculiar to these membranes, as miliary eruptions are to the cutaneous surfaces, as aphthæ to the mucous surfaces, &c. Add

to this difference that of the pus which the cellular texture and the serous surfaces secrete; this fluid is not the same in the two systems. The difference of its nature is not known; but its external appearance is by no means the same.

II. *Parts common to the Organization of the Serous System. Exhalants.*

A very evident exhalation is constantly going on upon the serous surfaces. A particular order of vessels is the agent of this exhalation, the matter of which is the fluid mentioned above. These vessels are very distinctly demonstrated in this system; it is the only one in which the eye of the anatomist can accurately trace them. The following are the means of seeing them; 1st, in a living animal, draw out an intestine from the abdomen; it will have a reddish tinge owing to the vessels under the serous coat, and hardly at all to the vessels in this coat itself. Irritate it, and reduce the intestine after attaching a string to it, as in the operation of hernia where there is gangrene, draw it out again at the end of six and thirty or eight and forty hours; it will exhibit many reddish lines, running over this serous surface, and showing in it plainly the exhalants which were insensible in the natural state, on account of the transparency of their fluids. 2d. Very fine injections cover in an instant all the serous surfaces with an infinite number of lines of the colour of the injected fluid, lines which are evidently exhalants full of this fluid. 3d. In these injections an extremely fine dew is made to ooze out upon the smooth surface of the serous membranes, a dew which takes place without rupture or transudation, and of which the exhalants are the sources. 4th. If a serous surface is laid bare in a living animal, and wiped dry, it is soon after covered with new serum, which the exhalants furnish.

Absorbents.

From the texture of the serous membranes, it is evident that the lymphatic system enters essentially into their formation, and that they are probably only a net-work of exhalants and absorbents; for we have seen that the cellular organ is an assemblage of them. But this assertion which analogy dictates is also supported by direct proofs. 1st. The fluid of the dropsies of the different cavities varies in density and colour; now Mascagni has always observed that the lymphatics in their neighbourhood contained a fluid exactly analogous. 2d. The same author has found in two dead bodies, with a sanguineous effusion in the thorax, the absorbents of the lungs loaded with blood. 3d. In a man who had become emphysematous after having been poisoned, these vessels were distended with air. 4th. Coloured fluids injected into the abdomen or thorax are soon after found, it is said, in the neighbouring lymphatics, with the same colour. I have often repeated this experiment; the injected fluid has been soon absorbed, but not the matter which coloured it; so that this matter, more condensed after absorption, tinged the serous surface, the lymphatics being as transparent as usual. It is necessary in general to choose the abdomen for these experiments, because the absorbents being much exposed on the liver, can be more easily examined there. This absorbent faculty is preserved some time after death; but care should be taken, in order to obtain then the effect more certainly, to keep the animal, if a warm blooded one, in a bath of nearly its own temperature; I have had frequent opportunities of being convinced of this truth, and of observing with Cruickshank, that what Mascagni has said upon the absorption of dead human bodies, fifteen, thirty, forty-eight hours even after death, is at least very much exaggerated. 5th. The following experiment I make every year to demonstrate the absorbents;

I macerate for five or six hours the heart of an ox in water; at the end of this time, the serous membrane of this organ, which hardly allowed these vessels to be perceived, appears to be covered with them. 6th. When the serous membranes are inflamed, the subjacent lymphatics are distended, like them, by the red globules of blood, &c. &c.

It appears then to be demonstrated, 1st, that the absorbents open by an infinite number of orifices upon the serous membranes; 2d, that their origins a thousand times intermixed with each other, and with the orifices of the exhalants, contribute especially to form their texture; 3d, that the difficulty of distinguishing the absorbent and exhalant pores is no reason for denying their existence, this difficulty arising from their extreme delicacy and from the oblique direction in which they open between the layers of these membranes; thus the obliquity of the insertion of the duct of Warton, and of the ductus choledochus even would render the inspection of them very difficult, though these ducts were infinitely larger; 4th, that from this structure, the serous membranes, always arranged as we have seen in the form of sacs without an opening, should be regarded as great reservoirs between the exhalant and absorbent systems, in which the lymph in going from one remains some time before entering the other, in which it undoubtedly undergoes various preparations of which we shall always be ignorant, because it would be necessary to analyze it comparatively in these two orders of vessels, which is almost impossible, at least for the first, and finally in which it serves different uses relative to the organs around which it forms a humid atmosphere.

Blood Vessels.

Do blood vessels enter into the structure of the serous membranes? These vessels are very numerous around

them, as is seen in the peritoneum, the pericardium, the pleura, &c.; they wind upon their external surface and ramify there. But I have always doubted whether the greatest number of those which are thus contiguous to them, really make a part of their texture, and I am even convinced of the contrary. The following considerations support my opinion. 1st. When these vessels are injected, they can be easily raised with a scalpel from the external face of these membranes, without injuring their continuity, which can never be done in the fibrous or mucous membranes. 2d. No blood vessel is discoverable on these membranes which are free on both faces. The arachnoides at the base of the cranium furnishes an example of this. 3d. The vessels frequently change relations with these membranes. I have proved above that when the omentum is applied to the stomach when it is full, the vessels that are between its layers, do not mount with it upon this viscus, on account of the great stomachic coronary which opposes it. When dead bodies having large hernias are injected, the vessels that wind in the ordinary state upon the surface of the peritoneum which corresponds to the ring, are not seen extending below upon the hernial sac. Certainly the vessels that are observed in the broad ligaments of the womb, do not follow them in the great displacements they undergo in pregnancy.

I think it then very probable that the serous membranes have but very few blood vessels; what are called arteries of the peritoneum, the pleura, &c. are but trunks winding on their external surface, capable of abandoning it when they are displaced, being as it were foreign to them, not entering immediately into their structure, to which the absorbent, exhalant and cellular systems almost alone contribute. No doubt communications exist between the arterial system and the serous membranes, by means of the exhalants; but nothing precise is yet known upon the

nature, arrangement, and to a certain extent even, the functions of these vessels.

III. *Varieties of Organization of the Serous System.*

We have seen the mucous system exhibiting in each part where it is found, numerous differences of structure and varying in each region and in each organ. The serous system varies also, though less than the preceding. 1st. Each membrane has its peculiar structure. Compare for example, the arachnoides and the peritoneum; the one fine, delicate and transparent, yields to the least effort, has no resistance, tears almost as soon as it is touched, never remains whole at the base of the cranium, where it is free, if the brain is raised ever so little, and has, when pressed between the fingers, a remarkable softness. The other, thicker and more compact, bears without breaking all the efforts imparted to the abdominal viscera; it can be pulled with impunity. Its texture is wholly different. 2d. The different portions of the serous membranes have not the same organization; the omentum is for example evidently dependant upon the peritoneum and yet it does not resemble it. I have observed that the intestinal portion of this membrane is much more delicate than its hepatic, mesenteric portions, &c. That the half of the tunica vaginalis which lines the albuginea and is identified with it, is certainly not the same as the half which is free on the side of the dartos muscle. I cannot say precisely in what these differences consist; but the external appearance is sufficient to establish them.

Ought we then to be surprised, if all the serous surfaces are not equally subject to the same diseases; if inflammation attacks them with such different degrees of violence; if it takes place ten times upon the pleura to once that it appears upon the arachnoides; if in the pericardium, the tunica vaginalis and the peritoneum, it does

not exhibit the same symptoms; if dropsies vary also wonderfully in each; if the slow inflammations attack them differently, &c.? The pericardium is subject to an affection which I have seen upon no other serous surface, and which is yet extremely frequent upon this; I refer to the white layers, more or less broad, that are formed on its internal surface, which would be thought at first view to belong to its texture, which can however be raised from it leaving it sound. I do not know whence these layers come; do they correspond to the false membranes of the pleura?

Neither should we be surprised at what has been said of the varieties which the same membrane exhibits in its diseases. Frequently the whole of the peritoneum is diseased, and the omentum remains sound and vice versa. The layers of which I have just spoken are seen upon the cardiac portion, and not upon the free portion of the pericardium.

Observe however that all the diseases of this system have a common character which is evidently derived from the analogy of organization. This and the synovial are the only ones in which large serous collections take place, in which slow and tubercular inflammations are formed. The most of their modes of adhesion belong only to the serous system. Inflammation has a peculiar and distinctive character in it, of which all the serous membranes partake with some modifications. The inflammation of the meninges had been classed among the serous phlegmasias, from the analogy of the symptoms, before I had demonstrated that the arachnoides, one of these meninges, belongs essentially to the serous system. It is on account of this membrane, and not on account of the dura-mater which is of a fibrous nature, that phrenitis should be referred to the diaphanous membranes.

ARTICLE THIRD.

PROPERTIES OF THE SEROUS SYSTEM.

I. *Properties of Texture. Extensibility.*

The serous membranes are endowed with an extensibility much more limited, than the enormous dilatations of which they are capable in certain cases, would at first lead us to believe. The mechanism of their dilatation evidently proves it. This mechanism depends upon three principal causes; 1st, upon the development of the folds that they form, and this is the most powerful of the three causes. Hence why the peritoneum, which of all the membranes of this class, is the most exposed to dilatations, as from pregnancy, ascites and visceral enlargements, more frequent there than elsewhere; hence, I say, why the peritoneum exhibits so great a number of these folds, such as the mesentery, the mesocolon, the mesorectum, the two omentums, the fatty appendices, the fold of the cæcal appendix, the broad ligaments of the womb, the posterior ones of the bladder, &c. &c. Hence why also these folds are seen around organs subject to habitual alternations of dilatation and contraction, as around the stomach, the intestines, the womb and the bladder; very evident in the second state, but slightly apparent in the first. 2d. The enlargement of the serous cavities belongs to the displacements of which their membranes are capable. Thus when the liver is considerably enlarged, its serous membrane increases its extent in part at the expense of that of the diaphragm, which being drawn is

detached and applied upon the enlarged viscus. I have seen, in an aneurism of the heart, the pericardium which had been able to yield but very little, detached in part from the portion of the great vessels which it covered. 3d. Finally, the texture of these membranes undergoes a real distension and elongation. But it is in general the least sensible cause of the enlargement of their cavity; it is only in the great enlargements that it has an evident influence; in common cases, the two first causes are almost always sufficient.

I will make an important remark upon the subject of the displacements of which the serous membranes are the seat in the motions of their respective organs; it is that these displacements are very painful when these membranes are inflamed. When the dilated intestines separate the two diseased layers of the mesentery to lie between them, when the stomach goes between those of the omentum, &c. when the peritoneum is inflamed, the patient suffers much. Hence why flatulence is then so painful, why it is then necessary to avoid taking at once a great quantity of drink. We know the acute pain that a long inspiration produces in pleurisy; it is because the lungs then dilate the pleura, and tend to go between the folds which accompany the great pulmonary vessels.

Contractility.

It corresponds with the extensibility; it is less consequently than it at first appears to be. When the peritoneum for example is contracted, its different folds are formed; it returns to its place after having experienced locomotions. But it cannot be denied that in great dilatations these two properties are very sensible; for example, in hydrocele as the water is evacuated, the tunica vaginalis evidently contracts. The peritoneum after the paracentesis of the abdomen exhibits the same phenomenon.

At the time of performing the operation of empyema, the pleura does not experience it so sensibly, not from defect of contractility, but because on the one hand it adheres to the ribs which do not contract, and on the other if the effusion is of long standing, the lungs are so flattened by the pressure, that the air can no longer dilate them, so that there remains a space between the costal and pulmonary portion, which is filled with air. A similar space would also remain at the moment of the operation, if the serum of hydrocephalus was evacuated.

After long distensions, the serous membranes no longer contract; the tunica vaginalis remains flaccid after frequent punctures, the peritoneum after frequent pregnancies, &c. &c.

II. *Vital Properties.*

The serous surfaces, being removed from the action of external bodies, do not enjoy in the natural state the properties which put the living organs in relation with external bodies; they have neither animal sensibility nor contractility. Thus they would be very improper for external integuments, or for linings of the organs which the mucous membranes cover; they would give in fact no other sensation than that of an obscure and indistinct feeling. They answer very well for envelopes, integuments for internal organs, but not for sensible envelopes. We have a proof of it in living animals in whom we can irritate these membranes with impunity. I have many times seen dogs in whom I had left the spleen drawn out of the abdomen, in order to observe the phenomena arising from it, tear this organ without being in a state of fury, eat it even and be thus nourished by their own substance. They also often tear without pain the exterior of their intestines when in experiments these are drawn out, and the animals are left some time to themselves.

When external bodies are in contact with the serous system, they change its natural state; they inflame it, as we see in the peritoneum, in the tunica vaginalis laid bare, as we observe also always when a foreign body introduced into the system acts upon them. Surgeons, as we know, even employ this means to which they would in vain have recourse in the mucous membranes, in order to procure artificial adhesions between the parietes of these membranes. The different morbid irritations inflame much more frequently the serous surfaces which in this state acquire a very acute sensibility, greater even than that of the integuments; so that these inflamed surfaces would be equally improper to serve for integuments, because external bodies would excite them painfully.

The sensible organic contractility is nothing in the serous system; but the insensible and the corresponding sensibility are kept in permanent exercise in it, 1st, by the continual exhalation and absorption that are going on there; 2d, by nutrition. These two properties are then those which predominate in this system; thus upon their alterations all its diseases turn. Acute inflammations, chronic inflammations with tubercles, adhesions, dropsies, exhalations of pus, of milky serum, &c. &c. are all derived from an excess, a defect or an alteration of these two properties of the serous system. It is then also almost exclusively that sympathies are put into action in it; so that the serous membranes diseased either idiopathically or sympathetically exhibit always a series of phenomena all of which suppose an increased internal motion, or loss of tone in the exhalant and absorbent capillaries, and in the peculiar texture of those membranes; whilst in the animal muscular, the organic muscular systems, &c. these predominant affections which are marked by convulsions and paralysis in one, and by irregular motions of irritability in the other, do not suppose this internal alteration of the

texture of the diseased organ. Hence why these two last systems, though frequently disturbed during life, exhibit but few changes after death, whilst the serous system is a vast field for the morbid anatomist.

Sympathies.

The serous surfaces are capable of being influenced by the affections of the other organs; this is very evident in the organic diseases of the heart, the lungs, the liver, the spleen, the stomach, the womb, &c. organs, which without having any known connexion of functions with the serous surfaces, influence them however so that all their morbid defects of organization are accompanied, in the latter periods, by different serous collections in the great cavities, collections evidently owing to a derangement of the organs which constantly exhale this fluid. I shall make upon this point two observations; the first is that the serous surfaces nearest the diseased organ, are in general the most susceptible of being influenced by it. Thus in the diseases of the heart and the lungs, the serous collections take place especially in the thorax, whilst ascites is always the first consequence of enlargements of the liver, the spleen, &c. the pleura and the pericardium being filled subsequently. We know that most sarcoceles are complicated with dropsies of the tunica vaginalis; whence results hydro-sarcocele, a disease which surgeons consider separately, but which is the same as those of the preceding cases, which might in this respect be called hydro-phthisis, chronic hydro-hepatitis, hydro-carcinoma of the womb, &c.

The second observation that I have to make is, that whenever the serum is thus collected in the cavities, in consequence of an organic disease of a viscus foreign to the membrane, this serum is limpid, transparent, and probably of the same nature as that which circulates in

the lymphatic vessels. The exhalants which form it not being then in fact diseased, their action not being increased or that of the absorbents diminished except by sym pathy, the fluid must remain the same. Thus though there is suffering at the end of the glans from a stone in the bladder, the glans is perfectly sound, and the mucous fluid that escapes from it is of the same nature as in the ordinary state. On the contrary, when dropsies depend upon a disease of texture of the serous surfaces, as for example upon a tubercular inflammation, or even an acute one, which has degenerated, &c. the effused serum is almost always altered; it is milky, or there are albuminous flakes in it, or a false membrane, &c. I have made this observation, which I think interesting, upon nearly all the bodies I have opened.

In acute diseases, the serous surfaces receive also equally the sympathetic influence of the affected organs. If we could then see them, we should find that they were like the skin, more or less moist, more or less dry, according to the different periods of the disease. What proves it is, that at the death which follows the disease, the serum of the pleura, the pericardium, the peritoneum, &c. varies remarkably. Sometimes it is evidently increased, at others it is almost nothing; this depends upon the time in which the subject died. If it is whilst exhalation is very abundant, we find much serum; it is almost nothing if life has been sufficiently prolonged to allow absorption to take place. If the surrounding air did not dissolve the sweat, or if the skin was in the form of a sac, we should find it with very variable degrees of moisture, according as the subjects had died in sweat, or with a suppression of the cutaneous exhalation.

ARTICLE FOURTH.

DEVELOPMENT OF THE SEROUS SYSTEM.

I. *State of this System in the First Age.*

All the serous surfaces are extremely delicate in the fœtus. In opening the thorax by a longitudinal section of the sternum and examining the pleura in the mediastinum where it is free on both sides, it is found to have less thickness than the transparent layers of the omentum or the arachnoides in the adult. The peritoneum is a little thicker in proportion, but yet its delicacy is very great. The comparison of soap bubbles is hardly sufficient to convey an idea of the fineness of the texture of the omentum and the arachnoides.

At this period the fluid that lubricates the serous surfaces is much more unctuous and viscid than it is afterwards; by carrying the fingers over these surfaces at the different ages, the difference is easily perceived. It might almost be said that the tangible qualities of the serous fluids then approximate those of the synovia. I know not to what this difference belongs.

Besides, the quantity of these fluids does not appear to be so great in proportion as that of the cellular fluids, with which they have however so much analogy; which is probably owing to this, that the internal motions being less numerous, on account of the inaction of most of the organic muscles, less fluid is necessary to lubricate the surfaces.

The growth of the serous system is always in proportion to that of the organs which it covers. The arach-

noides is larger in proportion than it will be in the adult; it seems even, like the brain, to become then the seat of a more active labour; thus diseases are more frequent in it. The increase of exhalation is more common in it than in all the other serous sacs; hence hydrocephalus.

At birth, when the internal motions become suddenly very numerous, on account of respiration, digestion and the excretions, I presume that the serous surfaces become the seat of a more active exhalation. Besides, as very little blood penetrates them, the sudden production of the red blood and its entrance by the arterial system, where it succeeds the black blood, produces less changes upon them than upon the mucous surfaces and the muscular system.

The serous membranes grow like the other organs; for a long time delicate and diaphanous, they gradually thicken as we advance in age, and become of a dull white. Their suppleness diminishes as their density increases; they resist the different reagents so much the less as the subjects are younger. In infants, maceration and ebullition reduce them much more quickly to a homogeneous pulp.

I have observed that in the fœtus which has become putrid, there is often collected different gases in the serous cavities, as may be proved by opening these cavities under water; a phenomenon much less evident in the adult, in whom the cellular texture is often wholly emphysematous by the putrefactive motion, without the escape of any thing by the canula of a trochar which is plunged into the peritoneal cavity or into that of the pleura, as I have many times ascertained. In general, there is disengaged much more aeriform fluid from the organs of the fœtus, than from those of the adult, in the experiments of maceration.

II. *State of the Serous System in the after Ages.*

In the adult, the serous system remains a long time without undergoing any very sensible change; its mem-

branes follow only the laws of the organs they surround. Thus in the age nearest youth, the serous surfaces of the chest are the most frequent seat of inflammations, dropsies, &c.; whilst in that bordering on old age the inferior surfaces like the peritoneum, are the more often affected.

In old age, the serous system becomes dense and compact; its adhesions to the neighbouring parts are more evident; thus it is less capable of the different locomotions of which we have spoken. Its forces, which are weakened, render absorption in it less easy; it is the frequent seat of dropsy. When it is affected with some diseases, its want of energy imparts to them a remarkable chronic character. There are many old people at the Hôtel Dieu with tubercular inflammations of the peritoneum, which they have had for a long time, whilst young persons are overcome much quicker by the same inflammations. Thus cancers in aged persons often remain almost inert, they frequently are not even painful, whilst their periods are usually most rapid in adults.

The serous effusions are more rare than the infiltrations of the sub-cutaneous cellular texture in old people; but they take place more commonly than those of the intermuscular texture.

The serous system becomes ossified, but not like the arterial, the cartilaginous, &c. from the natural effect of age. Its membranes are not constantly found osseous in old age, and when this phenomenon takes place, it happens at every age. It is a disease, a real tumour, whilst in the arteries and the cartilages it appears to belong to a natural series of functions. I have a preparation in which the arachnoides is evidently osseous in many points, and as it is upon the dura-mater that these productions are formed, their existence serves very well to prove that the arachnoides is distinct from it; for at the place where they are found, they can be easily separated from each other.

III. *Preternatural Development of the Serous System.*

I shall not repeat here what I have said, in speaking of the cellular texture, upon the formation of the different cysts. These cysts, completely analogous to the natural serous membranes, should be really considered as a preternatural development of these membranes in the economy; they have the same appearance and almost the same texture, furnish their fluid according to the same laws, and appear to be the seat of a constant exhalation and absorption; since they are in vain emptied by puncture, their fluids are always reproduced, until they are removed. For example compare the cyst which has grown preternaturally along the spermatic cord, with the tunica vaginalis filled with water in hydrocele. If the size of these tumours, which are often found together, is the same, it is impossible to discover any difference in their form, appearance, texture, properties, functions, &c.

SYNOVIAL SYSTEM.

I PLACE this system at the side of the serous, because it has the greatest analogy with it, under the relations, 1st, of its form, which is in each of these organs that of a sac without an opening; 2d, of its texture, which appears to be essentially cellular; 3d, of its functions, which consist in an alternation of exhalation and absorption.

What establishes a real line of demarcation between these two systems is, 1st, that the fluids which lubricate their membranes appear to differ in their composition, though there is much resemblance between them. 2d. In dropsical diatheses which affect at the same time the cellular texture and all the serous surfaces of the peritoneum, the pleura, &c. the affection does not extend to the synovial membranes, which indicates a difference of structure, though we do not know what this difference is. 3d. And reciprocally in dropsies of the articulations, an affection in general very rare, and in those of the tendinous synovial capsules, there is no concomitant affection of the membranes of the great cavities. 4th. The fluid of the articular dropsies does not resemble that which fills the great cavities in the same disease. 5th. The synovial membranes are much more rarely than the serous, the

seat of those slow and tubercular inflammations which the serous surfaces so often exhibit. I have however seen two examples of it in the synovial membrane of the knee. I believe that these two systems are the only ones in which this disease is observed; so that it is by its existence a character of resemblance, and by its rarity or frequency, a distinguishing attribute. 6th. The different kinds of adhesions of which I have spoken as taking place on the serous surface, are not met with on the synovial surfaces, where we see only that which identifies these two adhering surfaces, a mode which frequently takes place in anchylosis, which is also as often occasioned by it, as by the stiffness of the parts surrounding the articulation. 7th. The synovial surfaces are not as often as the serous, the seat of those remarkable locomotions of which we have spoken; which depends on this, that the articular organs are not, like the most of those covered with serous surfaces, subject to alternate dilatations and contractions.

The synovial system exhibits evidently two great divisions. To one belongs the articular system, to the other that of the tendinous grooves. Each shall be examined separately.

ARTICLE FIRST.

ARTICULAR SYNOVIAL SYSTEM.

I believe that I first described this essential portion of the synovial system. I shall relate here what I have said of it elsewhere. I shall examine first how it is separated

from the blood, afterwards the fluid itself, and then I shall describe the organ which furnishes it.

I. *How the Synovia is separated from the mass of Blood.*

Every fluid differing from the blood, can be separated from it to be afterwards transmitted to an organ, but in one of the three following ways; 1st, by secretion, a function characterized by the existence of a gland intermediate to the blood vessels that bring the materials to it, and the excretories which carry off the result; 2d, by exhalation, a function distinguished from the first, by the absence of this intermediate gland, and by the immediate continuity of the blood vessel and the exhaling duct; 3d, by transudation, a phenomenon purely physical, almost always happening after death, rarely observed during life, a simple transmission of a fluid by the pores of an organ, towards which it is mechanically determined. Let us examine which of these three modes is that chosen by nature to deposit the synovia upon the articular surfaces.

Is the synovia transmitted by secretion to the articular surfaces?

We are indebted to Clopton Havers for the system which places in the glands the sources of the synovia. Many authors had designated obscurely before him these organs in the articulations; but he made them the particular object of his researches, described them in the different articulations, divided them into two classes, the one principal, the other accessory, and assigned them characters so evident, that according to him, they could not be forgotten. Reddish bunches, spongy, formed by membranes folded upon themselves, situated sometimes without, and sometimes within the articulations, always arranged so as to be protected from too strong a compression, and pouring out through ducts in the form of fringe

the fluid they secrete; such are the characters drawn by Havers, which all anatomists since him admire, and the correctness of which the most modern and distinguished authors have acknowledged in their works.

Some anatomists of this age have however thrown doubts upon these glandular bodies. Lieutaud confounds them with the fatty cellular texture. Desault did not distinguish them from it. Every thing confirms me in the same opinion, which many considerations appear to establish in an undoubted manner. The following are these considerations; 1st, these reddish bunches are met with only in certain articulations. There are many of them in which their existence cannot be established but by supposition. 2d. The greatest number of the synovial membranes of the tendons certainly do not exhibit any of them, though Havers, Albinus, Juncke and Fourcroy admit them in all, founded no doubt upon analogy and not upon inspection. Yet the synovia is separated equally in both cases, and lubricates the surfaces of the articulations and of the tendinous sheaths; this separation is then independent of glandular action. 3d. If the best marked synovial glands are examined, such as that of the cotyloid cavity, no trace can be discovered there of this parenchyma of an unknown nature, but remarkable for its structure, which composes in general the glands, and which distinguishes them from every other part and forms their true organic character. 4th. No excretory duct can be demonstrated in these organs. Those in the form of fringes, admitted by Havers, are imaginary. Bertin himself has acknowledged this truth, though he attributed to these bodies a glandular structure. The transudation of the fluids injected by the arteries in the neighbourhood of the articulation, proves the existence of these ducts no better than it establishes them in the cavities of the serous membranes in which it also takes place, and yet in which it is well proved that no gland pours out the

albuminous fluid that constantly lubricates these cavities. 5th. Inflation resolves completely these fatty bunches into cellular texture. Maceration produces the same effect. When gradual and long continued ebullition has removed all the fat from them, there remains only a mass of cells pressed together, and similar to those of the common cellular texture. 6th. The glandular character is manifested in certain morbid cases, by a peculiar swelling and hardening, of which the other organs except the glands, such as the muscles, the tendons, &c. never offer an example. The liver, the kidneys, the salivary organs, all the considerable glands are remarkable for this. So true is this character, that it serves to indicate glands, the delicacy of which conceals them in the natural state. For example, the existence of the cryptæ of the stomach, the urethra, and several other mucous membranes, is founded first upon the analogy of the other membranes of this class, but principally upon the preternatural development which these cryptæ acquire in certain diseases. Never on the contrary, do the pretended synovial glands present to the observer a similar development. Always in the diseases of the articulations, a common swelling seems to identify them with the neighbouring cellular texture. They have not like the other glands, affections distinct from those of this texture, no doubt because they have not a peculiar vitality, because being mere elongations of the neighbouring cellular texture, they partake of its nature and properties, and ought consequently to partake of all its conditions, as it in its turn ought immediately to receive the influence of their affections.

The considerations which I have just offered successively form, I think, sufficient data to resolve the problem proposed above, by establishing as an incontestable proposition, that the synovia is not transmitted by secretion to the articular surfaces.

Let us examine the second mode of transmission stated by authors.

Is the synovia transmitted by transudation to the articular surfaces ?

It was an opinion anciently received, that the marrow of the long bones oozes through the pores of their extremities and through those of the cartilages which terminate them, to lubricate the articular surfaces. Havers renewed this idea forgotten at the time he wrote, united this source of the synovia to that which had placed it in the glands, and thus formed of this fluid a mixture composed of two fluids differently transmitted to the articulation. The most of those who succeeded him partook of his opinion upon this point. Those even, such as Desault, who rejected the existence of the articular glands and the secretion of synovia, admitted the transudation of it founded upon the following observations. 1st. A long bone, stripped of its soft parts and exposed to the air, allows a fatty oozing to pass through the pores of its cartilages which does not cease till the medullary juice is completely exhausted. 2d. The mechanical compression of the cartilaginous extremity of a long bone produces for a moment the same effect. Are these facts, which are evident in the dead bone, also real in the living one ? Different considerations, which I will now state, induce one to believe the contrary.

1st. The vital forces, the effect of which is to impart to all the organs which they animate a degree of tone sufficient to resist the entrance of the fluids, leave, when they are extinct, the fibres of these same organs in a state of laxity that renders them everywhere permeable. Thus transudation is now considered as hardly any thing else than a phenomenon that takes place only after death, which, if transformed into a vital one, would offer an evident exception to the laws of nature that are especially characterized by simplicity and uniformity. 2d. The

fatty oozing takes place in the experiment noticed above, not only through the pores of the cartilages, but also through those of the whole surface of the bone; so that by reasoning from what has been here observed upon the dead body, it is evident that during life the whole bone would be, if you may so say, immersed in an atmosphere of synovia, a consequeuce, which being proved false by the most simple inspection, demonstrates the falsity of the principle deduced from it. 3d. The articulations of the cartilages of the larynx are lubricated like those of the bones, by the synovial fluid; and yet here all transudation of marrow is impossible, as it does not exist in the substances of the cartilages. 4th. The marrow is almost always sound in diseases which, affecting the articulations alter the fluid that lubricates them. And reciprocally the synovia does not take a different character in the affections of the interior of the bones, which have an influence especially upon the medullary organ. 5th. Finally, the experiment that I have made, and which has been stated in the article upon the marrow, evidently proves the non-transudation of this fluid.

Desault, in order to explain the manner in which the synovia is separated from the blood, added to this pretended transudation of the marrow, an oozing furnished by all the parts contained in the articulation, such as the capsular and inter-articular ligaments, the internal fat, the cartilages, &c. A comparison will suffice to show the value of this hypothesis. What should we say of a system in which to explain the production of the serous fluid of the abdomen, the source of it should be placed in the liver, the spleen, the intestines, and in general in all the organs of this cavity? No doubt we should answer, that a fluid of the same nature, could not be furnished by parts of such different structure, that it is much more simple to search for a single source in the single membrane that covers all the gastric viscera. The application

is exact and the analogy perfect between it and the articular cavity.

We can, I believe, without fear of error, conclude from all that has been said above, that the synovia is not transmitted by transudation to the articular surfaces.

I will now examine the last mode pointed out for the separation of the synovia.

Is the synovia transmitted by exhalation to the articular surfaces?

The solution of the two preceding problems seem naturally to lead to that of the question which we here propose. The certainty of the two following data may, I think, be relied on; 1st. Secretion, exhalation and transudation are the only means by which a fluid different from the blood can be transmitted to an organ. 2d. Secretion and transudation are foreign to the transmission of the synovia. Now from these two certain data, can we not draw this conclusion as certain, that exhalation is the mode by which the synovia is carried to the articulations? But let us add to these negative proofs some considerations which establish this proposition positively.

The most striking relations are observed between the synovia and the fluid that lubricates the parietes of the serous membranes. 1st. The relation of composition. These two fluids are essentially albuminous. Albumen predominates in both, though a little different in each, as Marguerron has demonstrated. Havers had previously pointed out this analogy; he knew that these two fluids are coagulable by alkohol, the acids, and caloric, without knowing the principle to which this property is owing. 2d. The relation of functions. Both are destined to lubricate surfaces on which much motion takes place, to diminish the friction which is the inevitable consequence of it and to prevent fatal adhesions. Both are in the same state on their respective surfaces; it is merely a dew spread upon these surfaces, and soon taken up from them. 3d. The

relation of affections. Inflammation dries up the source of both, and produces adhesions, more common in the serous membranes and more rare in the articulations in which they produce anchylosis. Both are subject to preternatural enlargement, which is designated by a common word, viz. dropsy. 4th. The relation of absorption. The lymphatic system is for both the way by which they reenter the circulation, after having remained sufficiently long upon their respective surfaces.

Do not these various resemblances, which with some slight differences of composition only, so evidently connect the synovia with the fluid of the serous membranes, lead us to this very simple consequence, viz. that these two fluids being analogous in all other respects must be so also as to the manner in which they are separated from the mass of blood? Now it is a point in physiology at the present day generally acknowledged, that the fluid of the serous membranes is brought to them by exhalation; then we are evidently lead by induction to this which answers the question proposed above; The synovia is transmitted by exhalation to the articular surfaces.

This rigorous and accurate conclusion drawn from obvious and uniform facts will become, I think, a demonstrated truth, when to the analogies already established we shall add that of the membranous organ, the essential seat of the exhalation of the synovia.

II. *Remarks upon the Synovia.*

Thus separated from the mass of blood, the synovia has the appearance of a white, viscid and transparent fluid. It ropes, like some syrups, when it flows from the articulations. This unctuous property renders it peculiarly fit to lubricate the articular surfaces which rub together, and to protect them from violent shocks.

Its quantity varies; there are articulations which contain much of it; that of the ankle has always appeared to

me to have the most of it. Then come the ilio-femoral, the scapulo-humeral, the humero-cubital, &c. There are others in which there is scarcely any; such are the sterno-clavicular, the sterno-costals, the costo-vertebrals, &c. It is not the smallness of the synovial surfaces that occasions in these articulations the constant dryness that is observed in them; for the synovial sacs of the larynx, which are much smaller, are much more moist.

Besides, the synovia does not vary in quantity in each articulation, like the serum in the serous membranes. Those who have opened peritoneums, pleuras, pericardiums, &c. must have seen that hardly two are similar; sometimes there is only a mere dew, at others there is a real collection of fluid. Here on the contrary there is always nearly the same quantity; which is owing to this, that the synovial surface does not feel as easily as the serous surfaces, the sympathetic influences of the other organs when diseased.

The synovia is not subject to the different alterations which the serous fluids exhibit. I have never seen upon the articular surfaces what are called false membranes from inflammation. The preternatural collections of synovia never contain those white flakes, so common in the serous collections. I do not know of an example of milky serum effused in an articulation. One of the most frequent alterations of the synovia is that, I think, in which it takes the consistence of a jelly and is of a reddish colour, analogous, if I may be allowed the comparison, to currant jelly. Now this alteration is wholly foreign to the serous fluids.

These essential differences which the synovia and the serum exhibit in their alterations, evidently suppose a diversity of nature in the principles which compose them in the natural state. The viscidity of one and the greater fluidity of the other, also declare it, as Fourcroy has observed. This diversity of nature appears to depend espe-

cially upon a peculiar substance which enters into the composition of the synovia, which few animal fluids possess, which Marguerron who has observed it designates by the name of albumen of a peculiar nature, and which should be the object of new researches.

I shall not give here the details of the analysis of the synovia; they belong to animal chemistry.

III. *Of the Synovial Membranes.*

We have seen all the great cavities lined by the serous membranes, which form by their folds species of sacs without an opening, and which embrace both the organs and the parietes of these cavities. There exists in all the moveable articulations membranes precisely analogous, the uses of which are the same, the nature of which is not different and which I call synovial, because their parietes constantly exhale and absorb synovia.

Forms.

Every synovial membrane then should be considered as a sac without an opening, spread upon the organs of articulation, upon the diarthrodial cartilages, upon the internal face of the lateral and capsular ligaments, upon the whole of the inter-articular ligaments when they exist, upon the prominent fatty bunches in some articular cavities, &c. It is from it that these different organs borrow the smooth, polished and shining appearance which characterizes them in these cavities, and which they have not elsewhere. Just as by dissecting carefully the gastric organs, the peritoneum can be removed, its sac remaining whole, so we can conceive of the possibility of separating this membrane, notwithstanding the intimate adhesions it forms in some places. All the parts that it embraces are out of the articular cavity, though projecting into this cavity, as the lungs are found on the exterior of

the sac formed by the pleura, the liver on the exterior of the peritoneal sac, &c. &c.

The synovial membrane is found in all the moveable articulations, the greatest number of which has only it and the lateral ligaments. What is commonly called the fibrous capsule is only met with around some of the articular surfaces. The connexions of the humerus, the femur, and one or two other bones, the extremities of which are joined by enarthrosis, present the only examples of it. There are seen in these articulations two very distinct coverings. One which is fibrous is external, and is found arranged in the form of a sac open above and below, embracing by its two great openings the surfaces of the two bones, and being intermixed around them with the periosteum, the fibres of both interlace with each other. The other cellular, which is the synovial membrane, lines the first on the interior, separates afterwards from it when it arrives towards the two diarthrodial cartilages, and is reflected upon them, instead of being united to the periosteum. Boyer has pointed out this arrangement in regard to the femur.

In all the ginglymoid articulations, as in those of the elbow, the knee, the phalanges, the hand, the foot, &c. &c. the fibrous capsule is wholly wanting. The fibres, instead of extending and interlacing in the form of a membrane, are collected into fasciculi more or less thick, which form the lateral ligaments. There is only found in them the internal layer of the enarthrodial articulations, that is to say the synovial membrane, which does not contract here any adhesion with the periosteum, but is reflected upon the cartilages. By taking it at the place of this reflection, it can be detached far enough to prove that it has an external organization wholly different from that which the idea of a capsular ligament at first presents to the mind. This arrangement is very easily perceived by the least dissection, at the knee behind the tendon of the

cruræus and the inferior ligament of the patella, at the elbow under the tendon of the triceps, at the phalanges under that of the extensor, &c. All the arthrodial articulations have also an analogous organization, as will be seen in the Descriptive Anatomy; so that it is ascertained that the fibrous capsules exist but in a very small number of articulations, that almost all have only synovial sacs which are spread out and reflected upon the osseous surfaces, without being attached around them, as all authors have said.

I have proved this remarkable difference of the articulations by many dissections. Some anatomists were in the way to discover it, when they observed that the different capsules appeared to be wholly formed of cellular texture. It is in fact the texture of the synovial membrane, which differs essentially in this from the fibrous capsules. The mode of capsule for all articulations may be preserved, if it is wished, but different ideas must then necessarily be attributed to it. Compare, for example, the fibrous capsule of the femur with the synovial capsule of the knee; you will find on the one hand, 1st, a cylindrical sac with two great openings for the osseous extremities, and with many small ones for the vessels; 2d, a fibrous interlacing, similar to that of the tendons, the aponeuroses, &c.; 3d, a mode of sensibility analogous to that of these organs; 4th, the use of retaining strongly in place the articulated bones, which have only this bond to strengthen their union. On the other hand you will observe, 1st, a sac without an opening; 2d, a cellular structure, the same as that of the serous membranes; 3d, a sensibility of the same nature as theirs; 4th, the simple function of containing the synovia and separating it, the bones being tied by strong ligaments. Besides, the different reagents have upon the fibrous capsules an influence wholly different from that which they exert upon the synovial. Ebullition yellows them, renders them semi-

transparent, softens them like tendons and gradually melts them like gelatine. The synovial ones boiled remain whitish, and furnish but little of this substance. I would observe that the yellowish tinge and semi-transparency of the boiled fibrous capsules are a certain means of distinguishing the articulations in which they exist and those which are destitute of them.

The existence of the synovial capsule in the greatest number of articulations in which it is found alone, is placed beyond a doubt by the slightest inspection. In those in which it is united to a fibrous capsule, it is very clearly distinguished in several places. Thus in the thigh, it is found upon the interarticular ligament, upon the fatty bunch in the cotyloid cavity, and upon the neck of the bone at the places where it leaves the fibrous capsule, to be reflected upon the cartilages, &c.; but its adhesion to these cartilages and to the internal face of the capsule, may excite some doubts as to its arrangement in the form of a sac everywhere closed, which we have attributed to it; it is then essential to offer some considerations that may dissipate these doubts.

1st. However strong the adhesions of the synovial membrane may be, they can be destroyed without a solution of continuity, by a slow, careful dissection begun at the place where the membrane is reflected from the cartilage upon the capsule. It can be taken away in parts after long continued maceration. 2d. In consequence of certain inflammations, this membrane acquires a thickness and opacity which enable us to distinguish it from all the neighbouring organs, from those even to which it adheres the most. 3d. The synovial bags are all as adherent as the articular synovial one, to the cartilages of their sheath and to this sheath itself; yet every one acknowledges their distinct existence. 4th. There are articulations with a fibrous capsule, in which the fibres are separated so as to leave a space between them through which the synovia would

escape, if the synovial membrane did not line them. When air is forced into the articulation, this membrane rises up in these spaces and exhibits a texture wholly different from that of the capsule. Bertin observed this, but thought that these pellicles were insulated, and did not see that they depended upon the continuity of the membrane which is extended over the whole articulation. 5th. We have observed in the article upon the serous system, that the smooth and polished appearance which the surface of the organs and the cavities exhibit, is always given to them by these membranes, and that they never derive it from their peculiar structure; now we shall see that the synovial membrane has almost the same texture as the serous; then it appears that in the places in which the articular organs exhibit this character, it is from it that they receive it, though it cannot be distinguished as well upon these organs, as where it is free. Besides, the articulations that are evidently destitute of this membrane, have not this smooth and polished appearance. Such are the surfaces of the symphysis pubis, and of the sacro-iliac symphysis which are found, though contiguous, unequal, rough, &c. We have also proved that this organic form is never owing to compression.

From these different considerations we may be easily convinced, I think, that notwithstanding the adhesion of the synovial membrane at different points, it should be considered in a manner precisely analogous to that of the serous membranes, that is to say as a real sac without an opening, everywhere contiguous and spread upon all the organs of the articulation. Besides, do not the fibro-serous membranes exhibit similar adhesions, though the separate existence of the two layers which compose them is generally admitted?

From the idea we have formed of the synovial membrane, it is easy to conceive how certain organs pass through the articulation, without the escape of the syno-

via by the opening which receives or by that which transmits them The synovial membrane then reflected around these organs, forms for them a sheath which separates them from the fluid and keeps them distinct from the articulation. Thus the tendon of the biceps is no more contained in the articulation of the arm with the scapula, than the umbilical vein, the urachus, &c. are in the peritoneal cavity. With the least care it may be separated from the portion of membrane which forms its sheath.

The preceding considerations lead us also to find a perfect identity in the synovial capsules of the tendons and the articular synovial ones. In the preceding example, these two kinds of membranes are evidently continuous; for the capsule of the groove of the biceps is of the same nature as that of the tendons which have a separate one from it, as the flexors, for example.

Organization.

We have just seen, that the synovial membrane resembles very much in its external conformation the class of serous membranes, it does not less so in its internal organization. This organization is cellular, as is proved by dissection, inflation and especially maceration. The sac which the ganglions form is evidently only a production of the cellular organ; now it is known that this sac exhales and contains a fluid similar to the synovia. Wherever the synovial membrane is free, it is attached externally to this organ and is confounded with it in so direct a manner, that by raising successively its different layers they are seen to be gradually condensed and finally united together to form it. So that in the serous membranes no fibre is visible. It becomes transparent when it is separated accurately on both sides, which is easily done at the knee to a great extent.

I shall not go back to the various proofs which establish the cellular structure of the serous system; almost all

these proofs are applicable to the synovial system, which appears to be but a net-work of absorbents and exhalants. Hence it is easy to understand what the red and fatty bunches are that are found around the articulations. They perform in regard to this membrane the functions of the abundant cellular texture which envelops the peritoneum, the pleura, &c. &c. It is there that the blood vessels divide ad infinitum before arriving at the membrane where their ramifications, successively decreasing, finally terminate in the exhalants.

If a remarkable redness sometimes distinguishes these bunches from the cellular texture, it is because the vessels are more concentrated and nearer together in them. For example, in the articulation of the hip, the synovial membrane of which, almost everywhere adherent, only corresponds in the fissure of the cotyloid cavity with the cellular texture, nature has placed there almost all the arterial ramifications that furnish the synovia; hence the reddish tinge of the cellular bunch that is found there. On the contrary, at the knee where much cellular texture surrounds the whole external face of the synovial sac, the vessels more scattered leave to this texture the same colour as that of the external face of the serous membranes, &c. This redness of some pretended synovial glands, the only character that distinguishes them, is then as it were merely accidental; it no more indicates their glandular nature, than it proves it in the pia-mater, in which it is owing to the same cause.

Though the synovial membrane is very analogous to the serous surfaces, it must however exhibit differences of texture, since the fluid it exhales is a little different. In fact, by examining it at the femoro-tibial articulation, where it can be found in considerable pieces, it is seen to be more dense and compact than the serous membranes. Its texture has not the suppleness of theirs; when dried, it is much more brittle; it remains stiff, whilst the serous

texture is moved in all directions without the least effort. It resists maceration longer.

Properties.

The properties of texture become evident in articular dropsies, in which the synovial membranes are at first much distended, and in which they contract after the puncture, an operation however that is very rare. Yet it appears that these membranes are only susceptible of a slow and gradual extension. We know that suddenly separated in luxations, their parietes tear instead of stretching; they unite again after the reduction.

Among the vital properties, the organic sensibility is the only one of this system in the ordinary state, as I have proved by many experiments on living animals in which these surfaces have been laid bare and irritated by various agents. But the increase of life which inflammation produces by raising this sensibility, transforms it into animal sensibility; this is what is observed, 1st, in the wounds in which these membranes are exposed to the contact of the air; 2d, in the long continued irritation they experience from foreign bodies preternaturally developed in the articulation; 3d, in the various affections of the articular surfaces, &c.

This kind of sensibility of the synovial membranes serves to confirm what I have already established above, viz. that most of the articulations, the ginglymoid especially, are destitute of fibrous capsules. In fact, I have observed that these capsules, as well as the lateral ligaments, have a kind of animal sensibility, which is developed by pulling them; so that if all the neighbouring organs of an articulation, except the synovial membrane and the lateral ligaments, are removed and this articulation afterwards twisted, the animal gives signs of the most acute pain. But afterwards cut the ligaments, and leave only the synovial membrane, the twisting no longer

gives pain; then there is no fibrous capsule united to the synovial. This experiment, which is easily repeated upon the fore or hind legs, enables us to recognise everywhere the articulations in which the synovial membrane exists alone, and those in which it is found united to a fibrous capsule. This being of the same texture as the lateral ligaments, produces the same pains when it is pulled, as is proved elsewhere by experiments made upon the articulations clothed with these capsules.

The alternate exhalation and absorption which takes place upon the serous surfaces, prove the insensible contractility in them.

I have already observed that the synovial surfaces perform but a small part in the sympathies, that they feel but very slighly the affections of the other organs. Whilst in the acute affections of the important viscera, the skin, the mucous surfaces, the cellular texture, the nerves, &c. &c. have a greater or less sympathetic derangement, all the synovial membranes remain unaffected; they do not become the seat of irregular pains, nor of a more active or slower exhalation. They resemble in this respect the osseous, cartilaginous, and even fibrous systems. Thus it is not necessary that the physician should seek in the synovial system a frequent seat of the accessory symptoms in diseases, of that class of symptoms which does not belong to the injury of the diseased organ itself, but to its relations with other parts.

In the pains of the articulations, there are certainly cases in which the synovial membrane is diseased, and others in which the fibrous organs alone are affected. The distinction of these cases should be sought.

Functions.

The synovial membrane adds nothing to the solidity of the articulation. The fibrous capsules and the lateral ligaments alone serve this purpose. The smooth surface

which the articular extremities derive from this membrane, favours their motions; it can even in this way assist the muscular action; thus the portions of synovial membrane which are found at the knee behind the cruraeus, at the elbow under the triceps, at the phalanges under the flexors, &c. perform in respect to these muscles, the same functions as the tendinous synovial bags. They are to their tendons, what the cellular sac which separates the tendons of the psoas and the iliacus from the crural arch, is to them.

The principal use of the membrane of which we are treating is in relation to the synovia. It exhales by numerous orifices this fluid which remains there for some time, and afterwards re-enters the circulation by absorption. Its parietes are then the seat of exhalation, as the kidneys, for example, are that of the secretion of urine. The reservoir of the exhaled fluid is the sac without opening which it forms, as the bladder is that of the urine that comes from the kidneys. The excretory vessels of this same fluid are the absorbents which carry it into the mass of blood, as the urethra carries the urine from the bladder. There is under these different relations more analogy than there at first seems to be, between secretion and exhalation.

The phenomena of the continuance of the synovia in this membranous reservoir, have relation to the synovia itself or to the articular surfaces. The first consist in a peculiar but unknown alteration which it undergoes between the exhalant and absorbent systems. The second contribute to facilitate the articular motions. The unctuous and slippery coat which the serous surfaces receive from the synovia, is remarkably adapted to this use, as I have observed.

Natural Development.

In the fœtus and in infancy most of the synovial membranes are much larger in proportion than in the after

ages, because the articular surfaces have a greater extent in the cartilaginous than in the osseous state; but they are then extremely delicate. The synovia is not, as the serous fluids are at this age, more unctuous and of greater consistence; it appears even to be less so. Before birth it is in small quantity, no doubt because the motions are trifling.

In old age I have observed that the synovial membrane becomes more dense and compact. It loses in part its white colour and becomes grey; less synovia is exhaled from it. It is not like the serous surfaces, exposed to dropsies. The rigidity it acquires makes motion painful. It never ossifies except preternaturally. The phosphate of lime which gradually invades cartilage, does not take hold of it. I do not know an instance of an old person in whom bone has been found naked in an articulation.

Preternatural Development.

I have already observed in the article on the fibrous capsules, that when the head of a bone remains displaced in a luxation, it is not a membrane analogous to these capsules that is developed around it; it is a real cyst, smooth on its internal surface, moistened with serum, formed at the expense of the cellular texture, and presenting, with a little more thickness, the true appearance of the synovial membranes; it is a preternatural synovial membrane. The motions imparted to the displaced limb appear to increase the serous exhalation in this new membrane; hence no doubt the great advantage of these motions, in order to re-establish in part the mobility of the bones which remain out of their sockets. I have seen a dancer, the head of whose humerus was lodged in the hollow of the axilla, after a luxation that was not reduced, perform very varied motions with it.

ARTICLE SECOND.

SYNOVIAL SYSTEM OF THE TENDONS.

This system noticed by many authors and described by Fourcroy, Soemmering, &c. is precisely of the same nature as the preceding, from which it differs only by its situation; it is often even confounded with it. Thus the synovial membrane of the tendon of the biceps is continuous with that of the scapulo-humeral articulation; thus those of the gemelli are so with the synovial membrane of the femoro-tibial articulation; it is the same membrane which belongs at the same time to the tendon and to the articulation. A remarkable example of it is seen in the extensors of the leg and the ham, to the tendons of which the same articular synovial membrane of the knee serves for a capsule.

But very few tendinous synovial membranes are found in the trunk; almost all are on the extremities where they serve to assist the slipping of the tendons. They are met with, 1st, where a tendon is reflected at an angle upon a bone, as around those of the great lateral peroneus, the peroneus medius, the obturator internus, the great oblique of the eye, &c.; 2d, where a tendon slips upon an osseous surface without being reflected, as at the extremity of the tendo Achillis, as under that of the great glutæus, and those of the psoas and iliacus united; 3d, where a tendon slips in a fibrous capsule, as in those of all the flexors, &c. Their extent is uniformly in proportion to that of the tendons upon which they are spread.

Forms; Relations; Synovial Fluid.

The tendinous synovial membranes, are, like the articular ones, sacs without an opening, spread on the one

hand on the tendon and on the other upon the neighbouring organs. These sacs are differently shaped according to the arrangement of the tendon, but their general conformation is uniform. We see from this that every tendinous synovial membrane has two faces, one which forms the interior of the sac, which is everywhere free and contiguous to itself, the other which lines the adjacent organs.

The free surface is constantly moistened by a fluid precisely similar to that of the articulations, furnished like it by exhalation, and not as authors have said by red bodies situated in the neighbourhood, bodies of which oftentimes there is no trace visible, and which, when they exist, have nothing glandular in them. This fluid is in general much less abundant than in the articulations, at least in the dead body. But there are varieties in the different synovial bags; those of the tendo Achillis, of the tendons of the psoas and iliacus united, of that of the obturator internus, &c. are always more moist than those of the flexor tendons, &c.

Is it to the absence of synovia that must be attributed the species of crepitation which the tendons sometimes make in their motions? I know not. I would only observe that this crepitation has some analogy with the crackling noise of the joints of the fingers when they are bent quickly, a noise, which does not depend, as might be supposed, on the friction of the osseous surfaces; in fact, when it has been once produced, it cannot be again, though there may be friction again. Besides it is known that this crackling noise arises from the forced elongation of the phalanges, and consequently from the separation of their articular surfaces, as well as from the flexion.

The increase of the fluid of the tendinous synovial membranes forms a species of dropsy which is called ganglion, a tumour which never exists in the synovial membranes of the fingers, no doubt on account of the want

of extensibility of the fibrous capsules. It should not be thought however that all these tumours, which are cured by bursting them by strong pressure and thus effusing the fluid into the cellular membrane, have for their base a natural synovial membrane. Most frequently they are preternatural; they are cysts which are formed in the cellular texture. In fact these tumours are often found in the course of the great extensor of the thumb, where there is no synovial membrane. After rheumatic pains I have seen a considerable collection of fluid in the small synovial membrane of the tendo Achillis; it gradually disappeared. I have observed another analogous one in the bag of the psoas of a dead body. The fluid was reddish and of the consistence of currant jelly. The action of nitric acid immediately coagulated it into a white mass, analogous to the white of an egg hardened.

The adhering surface of the tendinous synovial membranes is spread, 1st, on the one hand upon the tendons, with which it is more or less intimately united. It is easily detached from those of the internal obturator, the psoas, &c. It is closely connected with those of the flexors. 2d. On the other hand, it commonly lines the periosteum, which, in this place, is penetrated with gelatine, and forms a fibro-cartilage. Its mode of relation is there analogous to that of the articular synovial membrane with the cartilage of the bone. Sometimes it is reflected upon a fibrous capsule after having lined the tendon; such are those which are in the neighbourhood of the scapulo-humeral articulation. In some cases, after having lined the tendon, they mount up to the fleshy fibres, as on the obturator internus. 3d. By reflecting from the tendon upon the neighbouring organs, they answer in general instead of much cellular texture; but in the grooves of the flexors, it is the fibrous sheaths which they clothe.

In all the great motions, the tendinous synovial membranes, stretched more or less, undergo various locomo-

tions, always less however than those of the serous surfaces.

The very various forms, which the sac without opening of the tendinous synovial membranes exhibits, can be reduced to two general modifications. 1st. Some are rounded sacs, species of bladders; such are those upon the supra-spinatus, the psoas, iliacus, obturator internus, &c. All these membranes are remarkable for this, that they never cover the tendon entirely, but only on one side; that they never form internal folds and that they are never surrounded by fibrous sheaths. 2d. The others, belonging especially to the flexors, and to the different tendons which traverse the sole of the foot, form at first a kind of cylindrical sac which lines the canal half fibrous, half cartilaginous in which the tendon slips; then they are reflected around it, cover it wholly and form for it a true sheath which prevents it from being moistened by the synovia. This kind of tendinous synovial membrane represents then truly two canals, at the superior and inferior extremities of which are found two cul-de-sacs which unite them and complete the sac without an opening. Internal folds are here frequently found going from one canal to the other. All the synovial membranes of the flexors have one of them under the tendon.

Organization; Properties; Development.

The organization of the tendinous synovial membranes is precisely analogous to that of the articular ones. Principally cellular, the texture of these membranes is without any apparent fibre; its softness is very evident; very few blood vessels are distributed to it, though the contrary has been said; absorbents and exhalants especially predominate in it. These, filled with blood in inflammation, give to the membrane, a reddish tinge, more or less deep. In this state the synovia is not exhaled; sometimes

even adhesions are formed, as I have observed in a subject in whom the fibrous sheaths and their tendons of the index and the middle finger seemed to be united. The inflammatory phenomena of the tendinous synovial membranes are especially remarkable in whitlows, a disease, one species of which has evidently its seat in the synovial membrane of the fingers, is analogous to the inflammation of the pleura, the peritoneum, and to that of the articulations. It is more dangerous than the inflammation of the synovial membranes in the form of bladders or bags, because the fibrous sheath which surrounds the inflamed membrane, not being able to stretch and yield to the swelling, like the cellular texture which surrounds the synovial bags, produces real strangulations, which it is often necessary to remove. I do not know whether the synovial texture of the tendons is exposed to the slow and tubercular inflammations, common to the articular serous and synovial systems. Its vital properties and those of texture appear to be precisely the same as those of this last. Like it, it receives with difficulty the sympathetic influence of the other organs; it is unaffected during the derangement of the other systems in acute diseases; it remains sound in their alterations arising from chronic affections. I would observe also that all its affections are almost local. For example, there is not, as in the serous system, species of dropsical diathesis, that is to say of cases in which all the synovial sacs are filled at the same time.

The tendinous synovial membranes, fine and delicate in the fœtus and in infancy, readily yield to the numerous motions which constantly succeed that age. More dense and compact in the adult, they become rigid in old age, exhale less fluid, are dry, and do not contribute a little, by the state in which they are, to the general slowness of the motions which that age brings with it.

There are many synovial membranes the existence of which is variable ; such as, for example, that of the great glutæus, in the place of which there is often found only a cellular mass. These membranes are in general very dry when they exist. Synovia can scarcely be discovered in them. They resemble in this respect the articular synovial membranes of the vertebræ, the clavicle, &c.

GLANDULAR SYSTEM.

THIS system, one of the most important in the animal economy, differs from most others in this, that the texture which is peculiar to it is not precisely the same in all the organs that compose it. The fibres of a muscle of animal life would as well serve for the structure of any other muscle of the same system. The tendinous fibres, the cartilaginous, osseous textures, &c. are everywhere the same. On the contrary, the texture of the liver would not serve to compose the kidney, nor that of this last the salivary glands. The glandular system then has a resemblance in its different parts only by certain general attributes which have many exceptions.

Authors have given the name of glands to organs to which it does not belong; such as the thyroid, the pineal, the lymphatic glands, those especially that are in the neighbourhood of the bronchia, the thymus, the suprarenal, &c. We should call by this name only a body from which flows, by one or many ducts, a fluid which this body separates from the blood which it receives by the vessels that go to it. 1st. On the head, the salivary, the lachrymal, the Meibomeian and the ceruminous glands of the ear, and the amygdalæ; 2d, the mammæ on the thorax; 3d, in the abdomen, the liver, the pancreas and

the kidneys; 4th, in the pelvis, the prostate and the testicles; 5th, on the whole trunk and the face, the very numerous collection of mucous glands; these are nearly all that are dependant upon the glandular system; all the other organs which belong to it by this name, are foreign to it in their texture, their properties, their life and their functions. In this point of view, the division of Vicq d'Azyr is inaccurate.

The extremities contain nothing which belong to this system, no doubt because the fluids which it separates almost all serve for the functions of organic life, whilst in the extremities every thing is in relation to animal functions.

ARTICLE FIRST.

SITUATION, FORMS, DIVISION, &c. OF THE GLANDULAR SYSTEM.

The glands have two different positions. Some of them are sub-cutaneous, as the mammæ, the salivary glands, &c.; the others deep seated, as the liver, the kidneys, the pancreas and almost all the mucous ones are removed from the action of external bodies. The greatest number occupy places where there is constantly much motion, as the salivary glands on account of the jaw, the mucous on account of the neighbouring fleshy layer, the liver on account of the diaphragm, &c. It is this which has made it believed that this motion, foreign to their functions, was destined to produce the excretion of their fluids.

But, 1st, the glands of the palatine arch, the pancreas, the testicles, the kidneys even, can hardly borrow accessory aid on account of their position. 2d. We know that the sight alone of grateful food makes the saliva flow. 3d. Sialagogues produce the same effect. 4th. When the bladder is paralytic, the mucous juices pour into it as before, oftentimes more copiously. 5th. The semen flows involuntarily. 6th. The excretion of the mucous juices is as easy in the pituitary membrane as any where else, though the fleshy layer, almost everywhere spread under the mucous system, is wholly wanting here. A thousand other analogous facts prove this truth placed beyond a doubt by Bordeu, viz. that the vital action is the essential cause of every excretion.

Accessory aid should not however be entirely rejected. In fact, in salivary fistulas, there is evidently more fluid thrown out during mastication than at any other time. It is evident that in the excretion of urine, the abdominal muscles perform the principal part. When the gall-bladder is emptied, I believe that the neighbouring motions are much assistance to it. In general, whenever the fluids are found in considerable quantities, if the parietes of the organs which contain them are not very strong, like those of the heart, the motions of the neighbouring organs are necessary to overcome the resistance which they offer. On the contrary, in the capillary vessels in which the fluids are in small quantities, the organ that contains them is sufficient, by its reaction, for the motion.

There are single glands like the liver, the pancreas, &c.; and others in pairs, as the kidneys, the salivary, lachrymal glands, &c. These resemble each other in general on both sides; but their resemblance is not to be compared for precision to that of the organs in pairs of animal life. One of the kidneys is lower than the other; their arteries, veins and nerves are not analogous either in length or size; frequently fissures exist in one that are

wanting in the other, &c. The same observation is true with respect to the salivary glands.

The glandular forms are not fixed and invariable; they exhibit a thousand different modifications in their size, direction and proportions; they have never the precise and exact conformation of the organs of animal life. This fact can be disputed by no one who has examined a number of dead bodies. The following are the means by which I have made this most evident to myself. We know that the organs vary much in size, in different individuals; now, in these varieties the proportions are always accurately kept in animal life, whilst it is rare that they are so in organic life. Let us take an organ for example in each of the two lives. I have always seen that in a small brain the corpus callosum, the thalami nervorum opticorum, the corpora striata, &c. are in proportion to the whole size of the organ. On the contrary, nothing is more common than to see a large lobe of Spigelius with a small liver, and vice versa a large liver with a small lobe. There is no anatomist who has not had frequent occasion to make this remarkable observation. A kidney is larger sometimes in its superior part, sometimes in its inferior, &c. It is in the whole of the organ that these varieties of size take place in animal life; it is oftentimes in insulated parts only in organic life. The reason of this appears to me to be that the harmony of action is necessary, as I have demonstrated, for the animal functions; so that if one side of the brain is more developed than the other, if one eye, one ear, one pituitary membrane, &c. are more developed than their corresponding organs, the perception, the sight, the hearing, the smell, &c. would be inevitably deranged; whilst the secretion of bile, of urine, &c. takes place equally well, though one part of these glands may be larger or smaller than the other parts.

There is a remark to be made respecting the glands with regard to these varieties of form, it is, that those which are covered by a membrane, as the liver, the kidneys, even the pancreas, are less exposed to them than those which are buried in cellular texture without having around them a membranous covering, as the salivary, the lachrymal, the mucous glands, &c. I have often examined these last in the mouth and in the course of the trachea; I never found them alike in two subjects. We know that the parotid sometimes extends upon the masseter, and sometimes does not, that it descends more or less into the neck, that it is of a greater or less size there, &c.

When one gland of a pair is wanting or becomes diseased, sometimes the other increases considerably in size, as I have seen in the kidneys. This takes place also in the treatment by compression of salivary fistulas, a treatment which does not however always succeed. In other cases, the sound gland increases its action and secretes more fluid, without increasing in size.

The exterior of the glands not covered by membranes is unequal and lobulated; it conforms to the muscles, the vessels, the nerves, and even the bones, as the parotid which is placed under the angle of the jaw. Less cellular texture is in general found around them, than around organs with great motion. That which is in contact with them is more dense and compact than that of the organic interstices. It closely resembles the sub-mucous texture, that exterior to the arteries, the veins, the excretories, &c. but it is not however so resisting. It receives fat with difficulty, and forms a kind of membrane, which, insulating to a certain extent the vitality of the gland, performs in great measure in this respect the functions of the peritoneum around the liver, of the peculiar membrane of the kidneys, the spleen, &c.

ARTICLE SECOND.

ORGANIZATION OF THE GLANDULAR SYSTEM.

I. *Texture peculiar to the Organization of this System.*

The glandular texture is distinct from most of the others in this, that the fibrous arrangement is wholly foreign to it. The elements that compose it are not placed at the side of each other, in longitudinal or oblique lines, as in the muscles, the fibrous bodies, the bones, the nerves, &c. They are found agglomerated, united by cellular texture, and adhere but very slightly. Thus whilst the organs with distinct fibres resist much, especially in the direction of their fibres, these are torn with the least effort, and break even with ease. Their rupture is unequal, full of prominences and depressions, a difference which distinguishes them from cartilage, the rupture of which is in general smooth. This rupture is not equally easy in all the glands. The prostate, the amygdalæ, the mucous glands resist much more than the liver or the kidneys, which principally exhibit this phenomenon. The pancreas and salivary glands yield a little without breaking, when they are pulled; but it is not their texture which is the seat of this phenomenon, it is the abundant cellular texture that penetrates them; thus their different lobes are then separated, in proportion as the filaments which are between them become longer.

The glandular texture, which is very commonly called parenchyma, is in general arranged in three different ways. 1st. In the pancreas, the salivary and lachrymal

glands, there are distinct lobes, separated by cellular texture resulting from smaller lobes which are agglomerated together and which are composed of still less lobes, that are called glandular grains; the scalpel traces with ease the first, second, third and even fourth divisions. 2d. In the liver and the kidneys there is found no trace of the first of these divisions, of those into principal and even secondary lobes. The glandular grains all in juxta-position, having between them an equal quantity of cellular texture, a quantity which is very small, as we shall see, present an uniform texture without inequality, which is broken with ease, as I have said, and the rupture of which exhibits species of granulations. 3d. The prostate, the amygdalæ and all the mucous glands have a soft parenchyma, like pulp, without the appearance of principal or secondary lobes, or even glandular grains, not breaking, yielding much more under the finger that compresses it, than that of the other glands. The simple inspection of the glandular system is sufficient to enable any one to perceive the triple difference which I have just pointed out, and which is essential. The testicles and the mammæ have a peculiar texture which cannot be referred to these differences.

Authors have been much occupied with the intimate structure of the glands. Malpighi admitted that there were small bodies in them, which he believed were formed of a peculiar nature. Ruysch determined that they were all vascular. Let us neglect all these idle questions, in which neither inspection nor experiment can guide us. Let us begin to study anatomy where the organs can be subjected to our senses. The exact progress of the sciences in this age is not accommodated to all these hypotheses, which made general anatomy and physiology but a frivolous romance in the last.

There is no doubt that the excretories communicate with the arteries which penetrate the glands. Injections

made in these escape with great ease by the first, without there being any trace of extravasation in the gland. The blood flows often naturally by the excretories, and produces sometimes bloody urine, saliva, &c. But do these facts prove that there are only vessels in the glands, that the peculiar parenchyma of which they are the result does not depend on a substance which is peculiar to them? The glands, like all the other organs, as the muscles, the bones, the mucous membranes, &c. have their peculiar texture which especially characterizes them, which belongs only to them, a texture in which the arteries communicate with the veins and the excretories. Let us not push our researches further; if we do, we shall be inevitably entangled in conjectures. Let us confine ourselves to examining what phenomena distinguish this texture from all the others when subjected to the different reagents. It is much to know the characteristic attributes of the glandular system, without seeking to understand its intimate nature, which, like that of all the other systems, is concealed by an impenetrable veil.

The glandular parenchyma dried in the air after having been cut in slices, loses its original colour, takes a deep one, black even in the liver and the kidneys, in which it is owing especially to the blood which penetrates these glands, since if they are dried after having been deprived of it by repeated washing, they remain grey after their drying. No system becomes harder or more brittle than this by this preparation. It diminishes then less in size than most of the others. When immersed in water after being thus dried, it becomes soft, resumes in part its original appearance and its tendency to putrefaction, which takes place immediately if it is left in the open air.

The glandular texture, when exposed to the air so that it does not dry, becomes putrid very quickly, and gives out an odour more fetid than most of the others. More

ammonia appears to be disengaged from it. The liver especially produces an insupportable odour when putrid. I do not know any organ, kept in a vessel full of water to macerate, which gives out more disagreeable emanations. The kidney becomes putrid much less quickly; this varies however a little.

When boiled, the glandular texture furnishes in the first moments of ebullition, a great quantity of grey substance, which mixes at first perfectly with the water which it renders turbid and then collects into a copious scum on the top of this fluid. It is this texture, the fleshy, the mucous and the cellular which give the most scum in boiling, as it is the cartilaginous, the tendinous, the aponeurotic, the fibro-cartilaginous, &c. which give the least of it. It should not be believed, moreover, that this first product of stewing is uniform in its nature; it varies in each system in quality as well as quantity. At least I have observed that its appearance is never the same, that it has nothing constant but its frothy state, which also varies much and which is even almost always nothing in the mucous system.

The liquor which results from the boiling is very much changed in colour, and appears to contain many more principles than that made with the white organs. An accurate analysis of the liquor in which each system had been boiled would be an interesting subject of research. I have found that in almost all the appearance, the taste and the colour were different.

The glands exhibit a phenomenon when cooking that especially distinguishes them. They harden at the moment of the first ebullition, and acquire the horny hardness like all the other systems; but whilst most of these soften again from long-continued stewing, so as to become pulpy, the glands uniformly become harder, so that after five or six hours boiling, they are three or four times as hard as they naturally are. I have very often made this

experiment, which is also well known in our kitchens, in which when a gland is cooked, care is taken that the stewing should not continue too long. Beef kidney finally becomes soft; those of sheep and of man remain hard for a much longer time. They soften however more than the texture of the liver, which is of all the glands that which exhibits the hardness in the greatest degree.

Another phenomenon which especially distinguishes the ebullition of the glandular system, is that when it is taken out at the moment it has undergone the sudden horny hardening, common to almost all the animal solids plunged into boiling water, it has not like the others acquired elasticity. Draw in an opposite direction a tendon, a serous or mucous membrane or a muscle that have undergone the horny hardening, they stretch and afterwards suddenly contract the instant the extension ceases; on the contrary, a slice of liver that has the horny hardness breaks when it is drawn and never contracts. The texture of the prostate appears to be more capable of then acquiring a little elasticity. The non-fibrous disposition of the glands seems to have much influence upon this phenomenon.

Exposed to the sudden action of a very bright fire as in roasting, the texture of the liver and the other glands crisps and contracts on the exterior. There results from it on the surface a kind of covering impermeable in part to the juices contained in the organ, which in this way becomes cooked in these juices which soften it in the interior. This phenomenon is however common to all the solids. Hence why care is taken to expose what is roasting, whether it be muscular or glandular, at first to the action of a very quick fire; afterwards when the horny hardning of the surface has been produced, it is diminished, and the organ is cooked with a small fire.

The glands macerated in water yield differently to its action. The liver resists it longer than the kidney,

which after an experiment of two months made in vessels placed in a cellar has been reduced to a reddish jelly swimming in the water; whilst the first preserved for the same time and a little longer, its form and density, and had only changed its red colour to a blueish brown, whereas the kidney retains its colour in maceration. The salivary glands contain much of this white, unctuous and hard substance, which all the cellular parts when long macerated exhibit. It is not the glandular texture that has changed, but only the fat contained in the cellular texture, which is here very abundant.

The acids act upon the glandular texture nearly the same as upon all the others. They reduce them to a pulp which varies in its colour and the rapidity of its formation, according to the acid employed. The sulphuric is uniformly the most efficacious in producing this pulp which it blackens, whilst the nitric yellows it. All the acids act with much more difficulty upon the glandular texture when stewed, than when raw. My experiments have convinced me that but few systems exhibit this difference in a more remarkable manner.

The glands are much less digestible than many other animal substances, especially when stewed, which produces in them in this respect an effect entirely different from what it does in the cartilages, the tendons, and all the fibrous organs, which by it lose their density, become soft, gelatinous, viscid even and are easier dissolved by the gastric juice. I believe in general that we should digest the glands much easier by eating them raw. Every one knows that the more the liver is cooked, the more indigestible it becomes. This induced me to make a comparative experiment upon this organ cooked and raw; when one portion in the second state was reduced to a pulp in the stomach of a dog, the other portion in the first state swallowed at the same time had just begun to be altered.

Of the Excretories, of their Origin, of their Divisions, &c. Of the Glandular Reservoirs.

All the glands have ducts destined to carry off the fluid which they secrete from the mass of blood; now as they are only found in the glands, they should be considered with the peculiar texture of these organs. The origin of these ducts is uniform in all the glands. They arise, like the veins, by an infinite number of capillaries, which form the last ramifications of a kind of tree, these ramifications appear to begin at each glandular grain, where these grains exist; so that for each there is one of these, an artery and a vein. Arising thus from the whole of the interior of the gland, these ducts soon unite and form larger ducts, which usually go in a straight line though the glandular texture, converge towards each other, unite with other ducts still larger and terminate differently.

In respect to this termination, glands should be divided into three classes. 1st. Some transmit their fluids by many ducts, each of which is the assemblage of smaller ducts, opening at the side of each other, but all entirely distinct and without communication. Sometimes at the place where these ducts terminate, a more or less considerable prominence is observed, as on the breast, as also on the prostate, of which the verumontanum is a kind of nipple. Sometimes there is a depression, a sort of cul-de-sac which is found at the place of these orifices, as in the amygdalæ, upon the tongue, &c. Sometimes the surface on which the different ducts of a gland open, is smooth and even, as is the case with that on which those of the lachrymal, sublingual and almost all the mucous glands open. 2d. Other glands pour out their fluid by a single duct, as the parotids, the pancreas, the sublinguals, &c.; this arrangement is only a modification of the preceding; where the duct opens, no inequality is usually

discovered, the surface is smooth. 3d. There are glands which, before throwing out their fluid by their excretories, deposit it for some time in a reservoir where it remains to be afterwards expelled; such as the kidneys, the liver, the testicles, &c. Here there are always two excretories, one which goes from the gland to the reservoir, the other from the reservoir outwards. These reservoirs are evidently a part of the same system to which their excretory ducts belong.

Though the first and second species of glands have no reservoir, yet the different ramifications of their excretories may to a certain extent be considered as such. In fact, these ramifications, as well as those of the excretories of the glands with a reservoir, are constantly full of the fluid which is secreted in these organs. Whatever may have been the kind of death, the fluid of the prostate may be always made to ooze out by compressing the gland; I have often even by pressure produced a very evident jet. The papillæ of the kidney also uniformly give out urine when pressed. The liver cut in slices allows natural bile to escape from the divisions of the hepatic duct. The semen is uniformly found in the windings of the vas deferens. The lactiferous vessels keep the milk in their cavity, till it is evacuated, and it has even no other reservoir. The greater or less size of the mammæ during lactation is owing to the greater or less fulness of these vessels. It is also to this circumstance that must be referred the peculiar taste of each glandular texture, which always borrows some sapid particles from the fluid it secretes. We know that the kidney has always an urinous odour, especially in old animals. It is to this also that I refer the difference of putrefaction which I have observed between this organ and the liver. We know that the bile undergoes putrid fermentation sooner than the urine; this, when it is very acid, can even preserve it to a certain extent from putrefaction; expose

then the liver and the kidney to it, the latter will almost always be the last to become putrid, as I have said.

It appears in general that the course of the fluids in the excretories is much less rapid than that of the blood in the veins and even than that of the lymph in the absorbents; the following considerations place this beyond a doubt. The urine flows continually by the ureters, as is evidently proved by fistulas in the loins; now, in the time taken to fill the bladder by this uninterrupted flowing, there would flow from a vein of a diameter equal to that of the ureter ten times as much blood, and much more lymph from the thoracic duct. Yet this rapidity of motion is subject to many varieties; during the period of inactivity of the glands, it is not half as great as during their activity; the salivary fistulas are a proof of this. We know how promptly the ureters transmit the urine from the drinks that are taken.

Size, Direction and Termination of the Excretories.

The size of the excretories varies. 1st. Those which go out in considerable number from a gland are very small, often hardly perceptible. They commonly run their course in a straight line, do not anastomose with each other and open immediately upon going out of the gland. 2d. Those that are single are larger, always in proportion to the size of their gland, except however the hepatic which is evidently very small in comparison with the liver. They run their course out of their glands, and arise from ducts as large as those of the preceding ones; so that if a single trunk arose from the excretories of these, they would resemble the others in every respect. They differ only in this, that their secondary excretories open directly on their surface, whereas they unite in a common trunk in the others. The pancreas is the only one in which this common trunk goes concealed in the

gland itself. It is only in the testicles that it is tortuous, and in which, on this account, it is longer than the course which it has to run.

Whatever may be their arrangement, the excretories pour all their fluid either on the exterior, as the urethra, and ureters, the lactiferous tubes, and the ducts of the sebaceous glands ; or on the interior of the mucous membranes, as the mucous, salivary, pancreatic, prostate and hepatic excretories. The cutaneous and mucous surfaces are the only ones then on which the excretories terminate, the only ones which their fluids moisten. These ducts are never seen opening upon the serous or synovial surfaces. The excretories of the pretended articular glands would be, if they existed, an exception to the laws of the general organization. The excretories never open in the cellular texture ; if this happens preternaturally, either abscesses take place from the irritation which results from it, as in urinary fistulas, or a callus forms in the course of the excreted fluid, and thus defend the cellular system from a troublesome infiltration.

Hence the mucous tube of the intestines should be considered as a kind of general excretory added to the pancreatic, hepatic excretories, &c. and which throws out all the fluids which are separately poured by these ducts into it. In fact, all the secreted fluids appear to be destined, as I have said, to be thrown out of the body. Separated from the mass of blood, they are foreign to it, and do not enter it in a natural state. Though still contained in cavities with mucous surfaces, they may be truly considered as being out of our parts. These surfaces are really true internal integuments, destined to defend the organs from the contact of the substances which they contain, a contact which would inevitably be injurious to them.

Remarks on the Secreted Fluids.

The fact that the secreted fluids are destined to be thrown out, a fact which is incontestable with regard to the urine, the bile which colours the excrements, the saliva, &c. has made me for a long time believe that the introduction of these fluids into the sanguineous system, would produce the most serious consequences. I was besides confirmed in this, 1st, by my experiments, in which I have always seen, as I have said, the urine, the bile, &c. injected into the cellular texture, remain without being absorbed, but producing abscesses; 2d, by the infiltration of the urine in the neighbourhood of the bladder, from which abscesses always arise; 3d, by the serious consequences from the effusions of this fluid in the peritoneum from the high operation for the stone, and of the bile on the same surface in certain penetrating wounds, in both these cases these fluids never re-enter the blood by way of absorption, like the peritoneal serum, but almost always occasion death; 4th, by an experiment in which I had seen a dog die shortly after the injection of urine into the jugular. All these considerations made me suspect that the secreted fluids, introduced again into the mass of blood, were always fatal at the end of some time, and that, as some physicians whose opinion is of great weight have thought, all that has been said of the bile's being poured into the blood in bilious diseases, is but a consequence of vague ideas of the reality of which there is no proof. Yet the importance of this question, in regard to medical theories, has induced me to resolve it by experiments, so as to leave no doubt upon the subject.

I have then injected into the jugular veins of many dogs bile taken from the gall-bladder of other dogs which I opened at the same time. For the first few days they appeared to be weary, did not eat, were much altered, their eyes were heavy, and they were constantly lying

down; but after some time they gradually regained their former vigour. I afterwards employed human bile in these experiments; the result was the same, except that many times the animal had hiccough and vomiting some time after the injection. In one instance a dog died in three hours after the experiment; but it was because I made use of that extremely black fluid that is sometimes found in the gall-bladder instead of bile which resembles thick ink, and which appears to form a considerable part of those black vomitings that sometimes take place.

These experiments induced me to try some with the saliva, and I obtained the same result from them: only the languid state that succeeded the injection was less evident. I afterwards made use of nasal mucus suspended in a sufficient quantity of water, for it can hardly be dissolved in it. Finally urine itself was many times injected, not that which comes immediately from drink and is only aqueous, but that which is of slow formation. In this experiment the dogs have been sicker, but only one died, and that happened on the seventh day. I have many times repeated it, on account of that which I performed three years ago; the same result has always taken place, which makes me think that being but little used at that time to make experiments, I introduced by accident a bubble of air through the syringe, which is sufficient to produce the death of the animal.

A question then is evidently settled by the experiment. The secreted fluids, though destined to be thrown out in the natural state, can re-enter the circulation, without causing the death of the animal, which is only more or less affected according to the nature of the fluid injected. Whether the bile circulates or not with the blood in bilious fevers, I have not examined; but it certainly can circulate with it after having been absorbed in its canals. I do not doubt but that in purulent reabsorptions, the pus

circulates in its natural state in the sanguineous system; I confess that I have not made experiments upon the injection of this fluid, but I intend to immediately.

We exaggerate every thing. No doubt the solids in which the vital forces are especially inherent, are particularly affected in diseases; but why should not the fluids be affected also? Why should we not seek in them causes of disease as well as in the solids?

There are cases in which these are primarily affected, and in which the fluids are so in consequence; thus in cancer, in the affections of the liver, the spleen, &c. in most organic lesions, the various yellowish, grey, brown and even greenish shades of the face, are an index of the consecutive alterations which the fluids experience in their colour and consequently in their nature.

In other cases the affection commences with them; as when the venom of the viper is introduced into the blood, as when reabsorption of pus takes place from external abscesses, or in phthisis, and as when there is absorption of various contagious principles. There is no doubt that the different substances which can be introduced with the chyle into the blood, may be the cause of various diseases. Is it not the blood which carries to the brain the narcotic principles which produce sleep? does it not carry turpentine and cantharides to the kidneys, mercury to the salivary glands, &c.? Inject opium, wine, &c. into the veins, and you will stupify the animal the same as if you had given them by the stomach.

Physiologists at one time were much engaged with the introduction of medicinal infusions into the veins of living animals. They circulated by these infusions purgatives, emetics and a thousand other foreign substances, the contact of which the blood bore, without occasioning any other accident to the animal than that of vomiting or alvine evacuations if they were emetics or purgatives, and a greater or less general derangement if they were other

foreign substances which had no affinity with any particular organ.

The caustics, as the nitric and sulphuric acids and other very irritating substances, have alone caused death in these curious experiments of which Haller has given us a sketch, and which prove that various substances wholly foreign to the blood can circulate in it, and that it is a common mass in which are found many principles differing from each other, and which cannot be always essentially the same. In these experiments the most important part has been neglected, that of the infusion of the different animal fluids, particularly the secreted ones, and those also which are preternaturally produced in diseases. I think that the different reabsorptions would be much elucidated by the infusion of the various kinds of pus, sanies, &c. But we have already sufficient facts to convince us that the fluids and especially the blood can be diseased; that the various foreign substances mixed with it can act in a fatal manner upon the solids. In fact, every acrid, irritating matter, without being mortal, accelerates the action of the heart and produces a true fever, if injected into the veins. In all these cases, it is always necessary that the solids should act; for all the morbid phenomena suppose their alterations; but the principle of these alterations is in the fluids. They are the excitants, and the solids the organs excited. Now if there are no excitants, there is no excitement, and the solids remain unaffected.

Finally there are cases in which the whole economy both solids and fluids seem to be simultaneously affected; such are adynamic fevers, in which at the same time that there is a general prostration of the first, the second appear to be really decomposed.

Let us not exaggerate then medical theories; let us regard nature in diseases as she is in a state of health, in which the solids elaborate the fluids and are at the same time excited by them. There is a reciprocal action,

every thing succeeds each other, every thing is connected together. Our abstractions hardly ever exist in nature. We usually adopt a certain number of general principles in medicine, and we accustom ourselves afterwards to deduce from these principles, as necessary consequences, all the explanations of diseases. There is in physical phenomena a regularity and uniformity which never deceive. In morals even, there is a certain number of principles acknowledged by all men, which direct them and regulate their actions; hence a constant uniformity in our manner of considering moral and physical phenomena; hence the habit of going always from the same principles in reasoning upon them. We have carried this habit into the study of the living economy, without considering that it incessantly varies its phenomena, that under the same circumstances they are hardly ever the same, that they are continually increased and diminished and have a thousand different modifications. Nature seems at every instant to be irregular, capricious and inconsequent in their production, because the essence of the laws which preside over these phenomena, is not the same as that of the physical laws.

I would observe that the experiments the result of which I have just given for the secreted fluids, differ from those which I published the last year, and in which these fluids have always been fatal, the instant they were forced towards the brain by the carotid. This is a phenomenon general to all the irritating fluids, whether drawn from the economy, or foreign to it; they destroy life when they arrive at the cerebral organ, by a direct injection and without having undergone any alteration, whilst we can inject them with impunity into the veins, as the experiments of the physicians of the last age have proved. We can even without danger, as I have observed, introduce them into the arterial system, on the side opposite to the brain, as in the crural artery, for example.

Do the fluids mixed with the black blood rid themselves of some principles by respiration, before they arrive at the brain, or is the preceding phenomenon owing to other causes? I know not. I would only observe that every thing which is not arterial blood, as the black blood and even serum, produces death when forced into the carotid. Water alone is injected with impunity. When the irritating principles are much diluted in this fluid, their contact is less injurious. I have seen very light coloured urine not produce death.

Structure of the Excretories.

All the excretories have an internal membrane which is mucous, and which is a continuation of the mucous or cutaneous surfaces, upon which they terminate. But besides this, they all exhibit an external covering which forms the shell, as it were, of this mucous canal. This shell is very thick in the vas deferens, in which it exhibits a texture but little known. In the urethra it is of a spongy nature, containing much blood and analogous to the glans of which it is a continuation. In the ureters, in the hepatic, salivary ducts, &c. it is this extremely dense and compact cellular texture of which we have spoken, which, by its structure, resembles that of the arterial and venous cellular texture, and which differs essentially from the ordinary cellular texture, as from the intermuscular. It does not appear that there is in these ducts a membrane differing from this dense texture and the mucous surface.

Each excretory has its vessels. The ureters evidently receive branches from the renal, spermatic arteries, &c. &c. The hepatic gives them to the ductus choledochus; the transverse artery of the face supplies the duct of Steno. Various nerves coming from the ganglions accompany the corresponding arteries and veins. Yet I have uniformly

observed that there is never around these ducts a plexus as evident as there is around most of the arteries.

The excretories have principally the vital properties of the mucous system which forms them in great part. Their sympathies are also nearly of the same nature.

II. *Parts common to the Organization of the Glandular System. Cellular Texture.*

The glands differ much in the cellular texture which enters into their structure. We may even, in this respect, divide them into two classes.

In all the salivary glands, in the lachrymal, in the pancreas, in all the glands with a granulated and white parenchyma, it is very abundant. Each glandular body is divided into lobes very distinctly separated by grooves which this texture fills, and which produce the lobulated appearance on the exterior of this species of gland; not only each lobe, but each lobule, each glandular grain even, has also the cellular texture for a boundary. In this respect, this sort of gland is truly an assemblage of small distinct bodies, which, separated from each other, would also perform well their functions. This is what is seen in the parotids, in which different accessory glands are often found in the course of the duct of Steno, and are perfectly independent of the principal gland. Sometimes there is a continuity, sometimes there is a separation between the sub-maxillary and the sub-lingual glands. The cellular texture is often loaded with much fat in this species of gland. This is especially remarkable in the mammæ, the size of which is owing sometimes to the glandular texture, as in young people in whom this texture predominates over the fat; sometimes to the predominance of this fat, as we see after the fortieth year, when this gland preserves a considerable size. The difference is easily perceived by the touch by the softness and flaccidity of

the organ in the second case, and by its resistance and firmness in the first. In the age of puberty often, it is also the fatty cellular texture which increases the size of this organ. Hence why there is often but little milk from a large breast, and a much greater quantity from a smaller one. In the voluptuous sensations which we experience at the sight of this organ, we distinguish very well, without being conscious of it, the breast whose prominence is real, from that which is not, and in which the fat only raises the skin of the breast. It is rare in the salivary glands, the pancreas, &c. that the cellular texture predominates so much, that the fat accumulates in them in so considerable a quantity. I have however seen cases in which the parotid resembled a fatty muscle; but there was no increase of size.

In the testicle, whose parenchymatous portions are separated as in the preceding glands, the cellular texture is not the medium of union. There is found between each grain species of threads which appear to be excretories, and not real cellular laminæ.

In the glands with a compact parenchyma, as the liver, the kidney, the prostate, the mucous glands, &c. &c. there is very little cellular texture; by tearing them in different directions, they break without exhibiting intermediate laminæ. Fat is never found accumulated in their parenchyma. The fatty state of the liver which takes place in many diseases, and which is not, as has been thought, an affection necessarily attendant upon phthisis, exhibits a phenomenon wholly different from the mammæ and the salivary glands when they have become fatty. The fat enters then like an element into the texture of the organ; it is in this respect like the colouring substance, whose place it has as it were taken; it is not found in cells. Moreover much of it can be extracted by ebullition, and I have observed that much of it swims on the surface of the water in which livers of this kind are boiled. The

kidney also has fat in its interior; but it is around the pelvis and not in its peculiar parenchyma. The amygdalæ, the prostate, the mucous glands, &c. never have it. Serum is never effused into the texture of the glands with a compact parenchyma. The most complete leucophlegmasia leaves them sound in this respect.

Yet it cannot be doubted that the cellular texture exists in these glands; maceration demonstrates it in them. In the fungous tumours that grow out of them, there is much of it. It is principally around the vessels that it is found; the capsule of Glisson is an example of this. It often happens even, as I have been led to observe, that this texture becomes diseased, whilst that of the gland remains sound. Thus we see steatomatous tumours developed in the liver, serous cysts in the kidney, hydatids in both, and various productions in the other glands, without deranging the secretion in the least. It is upon the liver especially that these observations are best made; its size is trebled, even often quadrupled by internal tumours, without an increase of its texture; this texture dilated forms between these tumours, species of partitions in which the bile is secreted as usual. The same thing takes place in the kidney, in which serous cysts are found. Sometimes these cysts grow there till the whole glandular texture is destroyed, and there remains only a large sac separated by membranous partitions, and filled with serum. I have preserved three kidneys of this kind.

Blood Vessels.

All the glands not covered by a membrane, receive their arteries from all sides. Numerous branches coming from the neighbouring vessels, penetrate the whole surface of the pancreas, the salivary and lachrymal glands, &c. These arteries wind at first in the interstices between the lobes, ramify afterwards between the smaller lobes and finally penetrate the glandular grains. Each of them has

its own artery; all communicate together; so that those of the sub-maxillary and the sub-lingual are filled by injection made by means of small tubes into the sub-mental, the external maxillary or the lingual, as well as by an injection of the trunk even of the external carotid.

In the glands surrounded by a membrane, as the liver, the kidney, the testicle, &c. the arteries enter only at one side, usually in a fissure, and by a single trunk which is very considerable, and which is sometimes divided into many branches more or less large. This part of the gland in which the artery enters is always the most distant from the action of external bodies, a remark common to all the important organs, as the lungs, the intestines, the spleen, &c. which always present externally their convex surface, that on which the vessels are the most ramified; so that the place where an injury can happen to them is that where hemorrhage is the least to be feared. The principal artery, after it has entered the gland, is soon divided into different branches which separate and are subdivided as they approach the convexity. They give off in their course many branches to the body of the gland and then terminate by a great number of capillaries on the convex part of the gland. They often even pierce the organ and ramify between it and the membrane which covers it. For example, by injecting the hepatic artery, if the liver is bare, many small blackish striæ suddenly appear on its convexity, which are owing to this cause. The best means of seeing the glandular arterial system, is to inject a kidney with a solid substance, and afterwards destroy its parenchyma by maceration or something else. The arterial system is then bare and entirely by itself. Many of these preparations are found in anatomical museums.

The great arterial trunks winding in the glands, communicate to them an internal motion very favourable to their functions. This motion is so much the more evi-

dent, as almost all these organs very near the heart by their position in the trunk, are, if we may so say, under the immediate jar of its contractions. The salivary glands, the mucous ones of the mouth and the lachrymal on the one hand, the testicle, the prostate and the mucous ones of the genital parts on the other, exhibit the extremes of this position. Another cause which favours the jar of the glands by the entrance of the blood, is that almost all the arteries that go to them run but a very short course before they enter them. The spermatic alone is an exception to this rule; thus, every thing in the secretion of semen seems to be characterized by a remarkable slowness. To this constant motion imparted to the glands by the entrance of the blood, should be added that which is communicated to them by the neighbouring organs, and which keeps them in a constant excitement, which is more necessary to their secretion than to their excretion. In considering the action of organs, the constant motions with which they are agitated has been too much neglected. The example of the brain ought however to fix the attention of physiologists upon this point.

The veins, everywhere continuous with the arteries, follow the same distribution in the glandular system, and accompany them almost everywhere. We do not see superficial and deep-seated veins, as we do in many other organs. The liver is the only example in which the red blood enters at one side, and the black goes out at the opposite.

Most of the veins of the glandular system pour their blood into the general system of black blood, and as many glands are very near the heart, they feel the reflux which this system often experiences. This phenomenon is particularly remarkable in the liver, as the hepatic veins open but very little below the right auricle. Hence why whenever this auricle is considerably distended, as in asphyxia and in death in which the lungs being crowded

present an obstacle to the blood, the liver has a much greater quantity than usual. I have uniformly made this observation. Weigh comparatively this organ when the auricle is full and when it is empty in the dead body, after having first tied all its vessels; you will find a very great difference. For the same reason, you will observe a constant relation between the weight of the liver and that of the lungs, provided a morbid alteration of texture of one of them be not the cause of death. The veins of many glands, as those of the mucous ones of the stomach and the intestines, as those of the prostate, &c. pour their blood into the system of abdominal black blood. There are hardly any in the system of which we are treating, but these veins, those especially of the glands situated in the pelvis, which become varicose. Varices of the prostate are frequent, as we know.

Of the Blood of the Glands.

The quantity of blood that is constantly found in the glands varies remarkably; they may even be divided in this respect into three classes. 1st. In the pancreas, the salivary, lachrymal glands, &c. there is found but very little. It does not furnish the colouring matter to these organs, which are white, and which, when macerated, tinge with red but two or three waters. 2d. In the mucous glands, the prostate, the testicles, and the amygdalæ, there is found a little more. 3d. The liver and the kidneys contain so great a quantity of it, that there is not in this respect any proportion between them and the rest of the glandular system. This is owing in a small degree in the first to the cause pointed out above; thus it often contains more than the second, but it is not the essential cause. After death by hemorrhage in which there was no reflux, in the liver or the kidney suddenly taken from a living animal, &c. we observe the same thing. In macerating these glands, it is necessary to renew the

water at least a dozen times before it ceases to be bloody. Hence why when they are preserved in alkohol on account of an organic disease of which they were the seat, they must be first macerated for a long time; if not, the liquor soon becomes turbid from the blood. It is this quantity of blood which gives to these glands a greater weight in proportion than that of the other parts. It is from this that their redness is derived, a colour which no other part exhibits to the same degree, but which is not more strongly inherent in their texture, than it is in the mucous surfaces or the muscles. In fact, we remove it with the same ease by repeated washing. Then the liver assumes a greyish appearance, which appears to be the colour inherent in its texture, as white is that of the fleshy fibre. The kidney seems a little less to derive its colour from the blood. It remains in part red when macerated; the pulp even which is the product of it, after remaining some months in water, that has been often changed, still exhibits in some degree this colour, much less however than in a natural state.

Does the state of the secretions make the quantity of the glandular blood vary? Does more of this fluid enter the kidney when it furnishes much urine, than when it secretes but little, or if the same quantity is brought by the arteries, is less returned by the veins in the first than the second case? This is an interesting subject for experiment.

Is the nature of the blood changed when it arrives at the glands? Has it a peculiar composition before entering each of them? Much has been said of this change necessary to secretion; but that this may take place, there must be a cause to produce it; now what is this cause here? Does not the blood circulate in the trunks which go to the glands, as in the others? It would be necessary then that the gland should be surrounded with an atmosphere which acts upon the blood at a certain distance

from the place where it is ; a vague idea, which has no solid foundation, and which is met with only in the books of those who have never made experiments. I have drawn blood from the carotid, spermatic, hepatic and renal arteries ; it is equally red and coagulable. In the same animal, it is impossible for the senses to discover the least difference.

I would observe that secretion differs essentially from nutrition in this, that it always draws the materials of its fluids from the red blood, whereas the second often takes its own from the white fluids, as we see in the tendons, the cartilages, the hair, &c.

Nerves.

The glands receive two species of nerves. 1st. The cerebral are found almost exclusively in the salivary and lachrymal glands, the amygdalæ, &c. 2d. The testicles, the prostate gland and the liver receive them in an almost equal proportion from the brain and the ganglions. 3d. The kidneys and most of the mucous glands receive scarcely any but those of the ganglions. What is now said of the nerves should be understood only of those that are free and independent of the arteries ; for each arterial trunk that enters a gland, is surrounded by a nervous net-work belonging to the system of the ganglions, which is very evident in the great glands, as in the liver and the kidneys where this net-work comes from the semilunar ganglion, in the salivary glands where it comes from the superior cervical, in the testicles where it comes from the lumbar ganglions, &c.

Compared with the size of the glands, the nerves are in small proportion, notwithstanding what Bordeu has said. It is not necessary in fact to judge of this proportion by those of the parotid and sub-maxillary glands, which merely pass through these glands without stopping

in them, and leave only some branches there. For example, there is certainly no organ in the economy, among those which receive nerves, that, in proportion to its size, has so few as the liver.

Besides, the nerves enter the glands nearly in the same way as the blood-vessels, that is so say, 1st, on all sides, in those that have no membrane; 2d, by a groove only in those that are covered with one. They divide and subdivide after entering it, and are soon lost sight of. Ganglions never exist in the interior of the glands.

Have the nerves an influence upon secretion? It is probable they have, as every gland is provided with them; but they by no means exert so immediate an influence upon this function as many physicians have pretended. 1st. It is said that the nerves of the parotid glands have been cut, and that the secretion of the saliva has been suppressed. This division is evidently impossible, since the gland must be extirpated before removing its nerves. 2d. I have divided the nerves of the testicle of a dog, the only gland in which this experiment can be made. I could not obtain any result, because an inflammation of the gland came on and it suppurated; but this suppuration even supposes that the nervous influx is not actually necessary for secretion, since suppuration is accomplished by a mechanism analogous to that of this function. All physicians know that a paralyzed limb can inflame and suppurate. 3d. Erection and the ejection of semen take place in paralysis of the lower half of the body, in which at least the nerves of the prostate gland are completely paralyzed. Mr. Ivan related to me the case of a soldier who took gonorrhoea in this state. 4th. We know that when the bladder is perfectly paralyzed and its nerves have no longer any action, its mucous glands still continue to secrete their fluid so as even to produce a catarrh. 5th. The nostril of the affected side in hemiplegia is as moist as usual. The ear of this side

has its ordinary quantity of wax. 6th. In paralysis of the uvula, the action of its glands continues. 7th. When the eighth pair of one side of a dog is cut, the bronchia is found some days after to contain as much mucus as common. 8th. During the convulsions of the different parts in which there are glands, and when consequently the nerves of these glands are more excited, their secretion is not increased. 9th. If we weigh the proofs given by Bordeu of the influence of the nerves on secretions, we shall see, that they either rest upon false facts, like those of the section of the nerve, of sleep, &c. or upon vague data. In general physicians attach no precise idea to the term *nervous influence ;* the habit of experimenting shows how much they have abused it. When a nerve being cut, paralyzed or irritated in any manner, the organ which receives it undergoes no derangement in its functions, we certainly are unable to appreciate the nervous influence upon this organ. I do not say that it does not exist, but I maintain that we know nothing about it, and that we ought not to employ at hazard a word to which we cannot attach any precise idea. What word will you employ then to express the influence of the nerves upon the organs of the senses, upon the voluntary muscles, &c. if the same one is used to express an action which has no relation with this, and which perhaps even does not exist ?

Exhalants and Absorbents.

This kind of vessels is but little known in the interior of the glands, where they perform only the purposes of nutrition.

ARTICLE THIRD.

PROPERTIES OF THE GLANDULAR SYSTEM.

I. *Properties of Texture.*

These properties are in general very inconsiderable in this system, which appears to me to be particularly owing to its non-fibrous texture. In fact, in order to be elongated and afterwards contracted and preserve their integrity, it is necessary that the particles of an organ should possess a certain degree of adhesion and cohesion; now, it is to the fibre that especially belongs this double attribute. Observe also that the glandular system is subjected to much less frequent causes of distension and contraction, than the systems with distinct fibres. It is scarcely ever found distended except when purulent deposits, serous, steatomatous collections, &c. are formed in its interior, as often happens in the middle of the liver, kidney, &c.; now in these cases it does not yield like the skin, the muscles, &c.; its particles are separated; it is the cellular texture with which they are surrounded that is uniformly dilated; the glandular texture is even soon destroyed. It is very evident when the collections are formed near the convexity of the glands; if the tumour be at all large the texture of the organ disappears; there remains only a cellular and membranous cyst. Hydatids so frequent on the exterior of the kidneys present us with examples of it. If it is in the middle of the gland that the cyst is formed, the destruction also takes place, but it is much less evident.

A strong proof of the small degree of extensibility of the glands, is what takes place in the liver in dead bodies. I have said above that it is more or less loaded with blood, according as the system with black blood had been more or less embarrassed in the last moments. Now whatever may be the quantity of blood it contains, its size remains nearly the same; only its texture is more or less compressed by the vessels, whilst on the contrary the greater or less size of the lungs, which is very apparent, always indicates its state of fulness or vacuity. It is probable even that it is this difference which has made all physicians neglect the infinitely various states of engorgment in which the liver may be found at death, whilst they have had a particular regard to the varieties of the lungs.

The veins of the kidneys, further from the heart, are less exposed than those of the liver to the reflux that takes place in the last moments in which the black blood is obstructed in the lungs. Yet it however takes place, and we see very great varieties in the quantity of blood in the great renal vessels, a quantity independent of that which is constantly found in the organ, and which, as I have said, is very considerable. Now the size of the kidney hardly corresponds to these varieties, because its extensibility is almost nothing.

As to the glands situated at the two extremities, as on the one hand the testicles, and on the other the salivary glands, we hardly observe in them the sanguineous stagnation, because the reflux is not sufficiently evident. We cannot then, in this way, judge but by analogy of their extensibility and contractility.

Yet the engorgements of the testicles, consequent upon gonorrhœa, and the various swellings of the parotid glands prove that these properties exist to a certain extent. Are the liver, the kidneys and other internal glands subject to those acute swellings that are often seen in the sub-cuta-

neous ones? It is very probable; perhaps even physicians have not paid sufficient regard to the accessory symptoms which may arise for a moment from the pressure of these swelled organs on the neighbouring parts. Besides, this swelling and the contraction that follows it, may take place especially in the cellular texture of the gland, and consequently suppose less extensibility of the glandular texture than they at first seem to.

II. *Vital Properties. Properties of Animal Life.*

The animal contractility is evidently nothing in the glandular texture. Does the sensibility of the same kind exist in it? The following facts are connected with this. 1st. A compression of the parotid is to a certain degree painful. I have even been obliged, in a particular case, to give up the method of compression that Desault had advised for a salivary fistula, on account of the pain the patient experienced; but the numerous nerves which traverse this gland may be the cause of these pains. 2d. We know that the instant the lithotome cuts the prostate, or the stone and forceps pass over it, the patient suffers very much. 3d. Stones lodged in the kidneys occasion horrible pains. 4th. Any considerable pressure of the testicle is very painful.

On the other hand we can cut the texture of the liver and the animal will give no signs of pain. Haller, after many experiments, ranked the glands among the insensible parts. What is to be concluded from this? That the animal sensibility, modified in a thousand ways, appears to exist in many organs in which certain agents cannot put it in action, and in which others develop it remarkably. We know that the various morbid alterations render it very evident in the glands. The inflammatory pain of these organs has even a peculiar character; it is obtuse and dull in the greatest number of cases.

There is never experienced in them the acute sensation which characterises cellular inflammation, or the sharp and biting pain of which the skin is so often the seat.

Properties of Organic Life.

Of the properties of organic life, the sensible contractility is wanting in the glandular system. But the two other properties are developed in it to the highest degree. They are in constant activity; secretion, excretion and nutrition keep them in incessant action there. It is by its organic sensibility that the gland distinguishes, in the mass of blood, the materials which are proper for its secretion. It is by its insensible contractility, or its tonic forces, that it contracts to throw out those which are foreign to this secretion. The first is on a small scale in each gland, what the animal sensibility of the tongue and the nostrils is on a large one, which allows only aliments suitable for the stomach to be introduced into its cavity; the other does insensibly, what is effected in so evident a manner by the glottis, when it rises up convulsively against a foreign body that attempts to enter it. The blood contains the materials of all the secretions, of the nutrition of all the organs, and of all the exhalations. Each gland draws from this common reservoir what is necessary to its secretion, as each organ does what is proper for its nutrition, and as each serous surface does what is suitable for its exhalation. Now it is by its organic sensibility that each living part of the body distinguishes what its functions require.

When the fluids enter the small vessels of the gland, this sensibility is the sentinel that gives notice of it, and the insensible contractility is the agent which opens or closes the gates of the organ, according to the principles that are presented. This comparison, if I may be allowed the use of it, gives an idea of what then takes place. Every glandular action turns then especially upon these two

properties, and as this action is almost permanent, they are then constantly in exercise.

From this it is evident, that all the glandular diseases ought to suppose a derangement in these properties; for, as we have often seen, they are the predominant properties of an organ, those, the exercise of which constitutes its peculiar life, which especially determine its diseases, by their alteration. This is in fact what observation shows us. Here we see these properties increased or diminished, sometimes produce an increase of secretion, as in diabetes, mercurial salivation, immoderate flow of bile, &c.; sometimes a diminution, a suspension even of this function, as in acute diseases in which all the ducts are closed as it were in a moment, as in the suppression of urine, dryness of the mouth, &c. It is the alteration in the nature of the glandular sensibility that puts it in relation with fluids foreign to the glands in a natural state; hence the innumerable varieties of the secreted fluids especially in diseases. I have spoken of these varieties as it regards the mucous fluids. The liver and the kidneys particularly do not experience less numerous ones. The taste, the colour, the consistence and odour of cystic bile appear in a thousand different states in dead bodies. Who is ignorant of the innumerable alterations of which the urine is susceptible? The saliva is less variable; but in diseases how different is it from its natural state. It is sufficient to have noticed for some time the various evacuations in diseases, to see of how many modifications they are capable. Nothing less resembles the urine and bile, than the fluids sometimes thrown out by the bladder and the liver; whence do these varieties arise? From this, that the variable organic sensibility places the organ in relation with substances to which it was foreign in a natural state; and from this, that the insensible contractility allows substances to enter the organ which it before excluded. The same gland without changing its tex-

ture, by a modification only of its vital forces, can then be a source of an infinite variety of different fluids; I believe even that the kidney, by taking a sensibility analogous to that of the liver, may secrete bile. Why may it not secrete it, if it can secrete other fluids so different from its own?

In health, each gland has a mode of sensibility nearly uniform, a mode which changes but little; thus each secreted fluid has an appearance, a consistence and a nature always nearly the same. But in diseases, a thousand causes change this mode at every instant. An hysterical paroxysm strikes the kidneys; in an instant they repulse all the principles that colour the urine, and this comes out limpid; the paroxysm passes off, the organ resumes its ordinary sensibility, and the urine returns to its usual state. The influence of the epileptic paroxysm extends to the sensibility of the salivary glands; in a moment, a thick, copious and frothy saliva, wholly different from the natural, comes from the mouth; after the paroxysm, the sympathetic storm is calmed in the gland, and the saliva returns to its ordinary state. If I may be allowed the comparison, the glands are in diseases like the atmosphere in the equinoxes. At these periods, the winds which succeed each other and incessantly change, often make rain, hail and snow succeed each other in a very short time; so the forces of the glandular life, constantly variable in diseases, make the different products of secretion vary with rapidity.

It is not only to secretion that the various alterations of the organic sensibility and the insensible contractility of the glands extend; these alterations when long continued, have an influence also upon their nutrition; they disturb the course of it; hence the changes of texture, the tumours of different kinds, the organic diseases, &c. that are so frequent in the glandular system, a system which presents the greatest field for morbid anatomy.

The great number of organic diseases which it exhibits, in our dissecting rooms, compared with most of the other systems, is very striking. The glandular, the cutaneous, the mucous, the serous, the cellular systems, &c. hold the first rank in this respect. Observe also that it is in them that the organic sensibility and the insensible contractility are raised to the highest degree, because they are the only ones in which these properties are brought into action not only by nutrition, but also by various other functions that are going on in the insensible capillary system, viz. by exhalation, absorption and secretion.

Sympathies.

Few systems are more frequently the seat of sympathies than this. In examining them I shall adopt the same order as in the preceding system.

Passive Sympathies.

The glandular texture is affected with extreme ease by all the others. This constitutes its passive sympathies. They take place, 1st, in a natural state; 2d, in diseases.

I say first that there are certain cases in the natural state, in which the other organs being excited, the glandular is brought into action. This is especially remarkable in the mucous system. We have seen that almost all the excretory ducts terminate upon the mucous surfaces. Now when one of these surfaces is irritated in the neighbourhood of an excretory duct, the gland of this duct increases its action. 1st. The presence of aliments in the mouth produces an abundant flow of saliva. 2d. A sound in the bladder, irritating the ureters or their neighbourhood, increases the flow of urine. 3d. The irritation of the glans penis and the extremity of the urethra in coition, produces a kind of spasm in the testicle from which arises a copious secretion of the seminal fluid. 4th. Every irritating fluid applied either to the conjunctiva, or the

pituitary membrane occasions a more or less considerable flow of tears. 5th. By making experiments upon the state of the gastric viscera during digestion and during hunger, I have observed that as long as the aliments are only in the stomach, the flow of bile is inconsiderable, but that this flow increases when they pass into the duodenum, so that much of it is then found in the intestines. During hunger, the gall-bladder is much distended; but little bile flows from it. At the end or even during digestion, it contains but half as much bile. Yet it might be emptied much more easily during abstinence, as the fluid which is then found in it is of a deep green, very bitter, very acrid and consequently very irritating. On the contrary, during or immediately after digestion, it is much milder, of a bright yellow and less irritating. There must then be another stimulus for it during digestion; this stimulus is the food that is passing by the extremity of the ductus choledochus. I have pointed out in a long note in my Treatise on the Membranes, the course of the cystic and hepatic bile.

Let us conclude from these numerous considerations, that one of the principal means which nature employs to increase the action of the glands, and to produce that of the excretory ducts is the sympathetic irritation of the extremity of these ducts or of the neighbourhood of the point of the mucous surface where they come out. It is to this also that must be referred the various catarrhs produced by an irritating body remaining upon one of these surfaces. The infant in sucking and irritating the nipple, produces a secretion of milk at the same time that he draws it out. In a morbid state the glands are also very frequently the seat of passive sympathies. It is almost always then the organic sensibility and the insensible contractility that are brought into action in them. It is rare, that the animal sensibility, excited by sympathies, occasions pains in the glands.

We have said that the varieties the glands exhibit in diseases are innumerable, either as it respects the quantity or the quality of the fluids they secrete. Now all these varieties are especially owing to sympathetic influence. Observe the salivary glands moistening the mouth or leaving it dry, filling it with a viscid or limpid fluid, frothy or thin, the mucous glands of the tongue furnishing sometimes a thick whitish substance, and sometimes a black crust. Physicians consider the state of the tongue as a constant index of that of the stomach; this is most often true. Nature has established such a sympathetic relation between these two parts, that when the mucous surface of the stomach is disordered, and is the seat of that kind of catarrh which is called derangement, fulness of the stomach, &c. that of the tongue is also affected and furnishes more mucous juices, which alter and destroy the appetite, and thus prevent the taking of aliments which the stomach could not digest, and which often even it would not bear. The tongue is then, as in a state of health, a kind of sentinel placed over the stomach, to refuse that which would injure, and to admit that which is suitable for it. This is no doubt the cause of this singular influence which the stomach exerts upon it in diseases. But let us also remark that sometimes the tongue is foul, when the stomach is in the ordinary state. This phenomenon is frequent in hospitals; it happens to me very often. And vice versa, nausea, &c. sometimes takes place without a catarrh of the tongue.

Shall I speak of the innumerable influences that the liver, the kidney and the pancreas receive? When an organ is diseased in the animal economy, these immediately perceive it; their secretion is increased, diminished or altered, and oftentimes even the sympathetic affection does not extend to these functions, but produces inflammation, suppuration, &c. We know that abscesses are formed in the liver from wounds in the head, &c. Shall

I speak of the innumerable varieties of the flowing of tears in acute diseases, in inflammatory and malignant fevers, &c.? Who does not know that the eye is then more or less moist, that it is often constantly weeping? Now whence arise these varieties? from the sympathetic influence which the lachrymal gland receives. The disease itself is often foreign to it; but the unknown consensus which connects the glands with the diseased parts, makes them then enter into action. We weep from a variety of passions, from grief especially; how does this happen? Because the influence of the passion is first carried to the epigastric region, as the violent sensation experienced there, proves; and the affected organ reacts upon the lachrymal gland. We weep in the same way as we sweat from fear, or spit copiously in anger, a phenomenon which the vulgar express by these words, *foaming with rage.*

The testicles and the prostate are much less often sympathetically influenced in diseases than the other glands. Whilst every thing is disturbed in the glandular system, they most frequently remain calm and tranquil. Why? because they are insulated by their functions from the other glands. The salivary glands, the pancreas, the kidneys, the liver and almost all the mucous glands contribute to one common object, viz. digestion. This object is connected with the existence of most of the other organs. When these are diseased, it is not wonderful that the glands feel it. On the contrary, the testicles, destined only to the purpose of generation, entering later into action and ceasing to act sooner than the other glands, having great intermissions in their action, cannot in their affections be thus connected with the diseases of the other organs. Sometimes however they are. We know that some affections of the lungs dispose to venereal pleasures; that in a natural state, a lively excitement of certain parts

of the skin, of that of the glutæi muscles especially brings into activity the whole genital system, &c. &c.

We know the remarkable sympathy that renders the mammæ dependant upon the womb. It is well known, that they swell a little every month, at the beginning of menstruation; that cancers are often formed in them at the cessation of this natural discharge; that the voluptuous sensation of coition sometimes extends even to them, &c. All physicians have observed this sympathetic relation which appears to be of a peculiar kind and to depend upon the analogy of the functions of the sympathizing organs.

After severe acute diseases, especially idiopathic fevers, the glandular action is oftentimes much increased; there are great evacuations; these are the crises; it is, according to the opinions of most, the morbific humour that is expelled. This is a phenomenon that should be examined, and which certainly in many cases does not depend, as I shall prove, on the cause to which it has been attributed.

Though I consider many of the secretory derangements in diseases as sympathetic, I am far from thinking that all are so. Certainly in many cases, there is a general affection of the whole system, an affection in which the glands, like all the other parts, participate; this is what takes place in idiopathic fevers. But when one system is especially affected, as the cutaneous in the small pox, the measles, scarlatina, &c. the serous in pleurisy, peritonitis, &c. the cellular in phlegmon, the nervous in convulsions, &c. I call the derangement which the others experience sympathetic, and which does not depend upon an injury of their texture.

Other ideas may be attached to the word sympathies, but these are what I have connected with it in diseases. The word is of but little consequence, provided what it expresses is understood.

Active Sympathies.

These sympathies are less frequent than the preceding. In the diseases of the glandular system, we see however examples of them. The history of inflammations of the kidneys, the salivary glands, the liver, &c. shows us many phenomena arising sympathetically in the other systems on account of the diseases of this. I do not speak of the derangement of digestion and the circulation, functions which, naturally connected with the secretions, are inevitably deranged when these are; I speak of the organs, which having no direct relation with the diseased glands, are yet affected, as we see in convulsions, spasms, wandering or fixed pains in different places, sweats, &c.

The testicles in health exert a remarkable influence upon the organs of the voice. We know that it becomes more harsh the moment they enter into action, and that it changes when they are removed by castration; this phenomenon is constant and invariable. Barthez believed that it arose from the ordinary sympathetic phenomena; in fact, it appears to be but a particular modification of that general influence which the testicles exert on all the vital forces, which are uniformly debilitated or strengthened, according as their action is feeble or strong. Yet some organs are more disposed than others to feel these affections. The pectoral mucous system is an example of this. Passive hemorrhage of this system is frequently the consequence of excessive excretion of semen; phthisis even is often the fatal effect of it.

Characters of the Vital Properties. First Character. Life peculiar to each Gland.

The glandular life, the result of the preceding forces considered in exercise, is not uniform in the whole system, no doubt because its texture differs in each gland, and because to each texture is given a peculiar modifica-

tion of vitality. Many phenomena result from these differences which have been well observed by Bordeu.

1st. Each gland has certain substances with which it is exclusively in relation in the natural state. Hence why the salivary glands do not secrete bile, and the liver allows the materials of urine to pass in its vessels without separating them; from this results the diversity of secretions. Hence also why cantharides affect exclusively the kidneys; why mercury acts especially upon the salivary glands; why certain substances affect the testicles in a peculiar manner, increase their secretion and even promote the excretion of the semen; why some aliments give more milk than others. I am persuaded that certain substances act upon the mucous glands and dispose them to a greater secretion.

2d. Each gland has its peculiar mode of sympathies. We have seen that the testicles sympathize especially with the pectoral organs, and the liver with the brain. The kidneys, when affected with acute pain, have an influence peculiarly on the stomach, and occasion vomiting. The mammæ and the womb are directly and particularly connected in sympathies.

3d. The inflammation of each gland has a particular character. That of the kidneys does not resemble that of the liver, the testicles, &c. The prostate gland when inflamed produces symptoms wholly different from those of the testicles, &c. I do not speak of the differences resulting from the diversity of the fluids, but only of those which arise from the difference of texture.

4th. Each gland has its peculiar diseases, or such at least to which it is disposed more than the others. Hydatids are very often found near the convexity of the liver; they are never seen in the salivary glands or the testicles. Though the parotid glands are as much exposed to the action of external bodies as the testicles, there are twenty sarcoceles to one scirrhus of these glands. The

liver alone exhibits that peculiar state that is called fatty; no gland is more frequently the seat of steatomatous tumours. Physicians who have opened but few bodies, employ the vague and insignificant word *obstruction*, &c. for every kind of glandular swelling. But observe that most commonly these swellings have nothing in common among them but the increase in size; their nature is wholly different, and yet observe how ignorant many are in medicine; they perceive by the touch that there is a hardness of the liver, and immediately aperients, the acetate of potash, &c. are the common means which they oppose to hydatids, to steatomatous tumours, to scirrhi with granulations like marble, to fatty livers and to a hundred different alterations from which the increase of size may arise, as if it was this increase and not the kind of tumour that produced it, which they had to combat. Give then also aperients when the liver displaced by hydrothorax projects unnaturally, and you will act almost as rationally.

5th. Each gland exhibits peculiar modifications in those evacuations that are called critical, of which it is sometimes the seat after long diseases, &c. &c.

6th. It is also to the difference of vitality of the different parts of the glandular system, that must be referred the following phenomenon; certain glands enter suddenly into action, either from a direct irritation, or a sympathetic excitement, as the lachrymal for example, which from a state of remission passes suddenly from the influence of the passions, to that of copious secretion. On the contrary, it requires some time to excite the other glands, as for example the kidneys, pancreas, &c. which cannot suddenly pour out their fluids, whatever may be the excitement they experience. The same stimulus applied to the conjunctiva, produces a flow of tears, and at the same time increases the action of the Meibomian glands: but the first effect takes place before the other.

The same stimuli applied to the mucous surfaces can never produce a catarrhal discharge till the expiration of some time.

Second Character. Remission of the Glandular Life.

The second character of the glandular life, is that of being subject to habitual alternations of increase and diminution. Sleep extends especially to the animal functions; they alone are completely suspended in the ordinary state, and it is this which constitutes sleep. But the glands sleep also to a certain extent, though there is never a complete suspension except in diseases. I would compare the sleep of animal life to the intermissions of intermittent fevers in which the apyrexia is complete, and the sleep of the glands to those of remitting fevers in which the paroxysm is only moderated, though it always continues.

The saliva is copiously poured out when aliments enter the mouth, at other times it only moistens this cavity. Whilst the chyme is passing through the duodenum, the pancreas and liver moisten it abundantly; they are also in action during hunger, but in an infinitely less degree. I have convinced myself of this by many experiments upon the comparative state of digestion and hunger, the substance of these experiments I have given elsewhere. We know that it is some time after eating before the kidneys commence their action. The intermissions of the action of the mammæ are almost as real as those of the organs of animal life. Each mucous gland has its time of secretion; it is that in which the surfaces, to which the excretories go, are in contact with any substance that is remaining there, or that is only passing.

The glands then must be considered as continually separating a fluid from the blood, and as being at certain periods in greater activity, and consequently as furnishing more fluids.

This remission of the glands appears to be owing to a cause nearly analogous to that of sleep, which, in animal life, is produced by the weariness the sensitive and locomotive organs experience, after long continued action. The kind of weariness which the glands are capable of experiencing, is not in general attended with a painful sensation, as in animal life; its nature appears to be wholly different. Yet women, after nursing too long, feel a pain in the breast that warns them to leave off. The testicles become the seat of a painful sensation, when the emission of semen has been many times forced.

Third Character. The Glandular Life is never simultaneously raised in the whole system.

The vital properties of the glands are never simultaneously excited in all. When one is in action, the others are in remission. We might say, that there is but a determinate quantity of life for all, and that one cannot live more without the others living less. To this law is the digestive order accommodated. In the first period the salivary glands furnish at first a great quantity of fluid; in the second, the parietes of the stomach; in the third, in which the chyme passes into the small intestines, the liver and the pancreas are principally in action; in the fourth, it is the mucous glands of the great intestines which especially act; and finally the kidneys enter into a particular action in order to evacuate the residue of the fluids. All the glands cannot act at the same time; it is as in the external motions in which certain muscles always rest whilst the others contract. The most improper time for coition is that of digestion, because we then make the mucous, hepatic, pancreatic secretions, &c. coincide with that of the testicles. In diseases one gland increases its secretion only at the expense of the others. Observation proves this every day.

We might, as I have said, make use of this remark, by producing in various glandular and other affections, artificial catarrhs, a disease which we can always produce on the mucous surfaces by the introduction of a foreign body. I have for some time past made much use of ammonia respired by the nose. Pinel prescribes it before the paroxysms of epilepsy. There are an infinite number of other cases in which it is very efficacious, as in some kinds of cephalalgia, in ataxic fevers, in certain apoplexies, in various comatose affections, &c. A blister does not act till the expiration of some time; it requires four, five, six hours even for it to produce an irritation. Who does not know that oftentimes in diseases in which the forces are much prostrated, it has no action on the cutaneous system? On the contrary, the excitement of the pituitary membrane by ammonia is always sudden on the one hand and always efficacious on the other. Its effect, it is true, is only instantaneous, but this is precisely its advantage; for in many cases a blister is only useful the moment it irritates the skin; hence the use of drying it immediately and reapplying it. The employment of ammonia or of any other strong stimulant upon the pituitary membrane, can be repeated every quarter of an hour, every five or six minutes or even every minute. If habit renders the patient less sensible to its excitement, we can replace it by another irritating substance, whereas we cannot thus change the cutaneous excitement by a blister. What I have said of the pituitary surface is applicable to those of the rectum, the urethra and stomach, on which we can in many cases apply in diseases excitements in a more advantageous manner than is done upon the skin by means of blisters.

Moreover, the character of the glandular life of which we are treating, is only an insulated modification of a character general to all the vital properties, a character which consists in this, that they are weakened in one

place when they are raised in another. Hence why the great collections of pus, large tumours and dropsies are always attended with a weakness in the glandular action. It is upon this character that rests the use of vesicatories, setons, moxa, cauteries, &c. which do not act, as has been said, by evacuating the morbific matter, but by making the irritation of the diseased part cease by that which is produced elsewhere.

Fourth Character. Influence of climate and season on Glandular Life.

Another phenomenon is also derived from the preceding character, and it is one that may be likewise considered as characteristic of the glandular system; viz. that in general it is in greater activity in winter than summer, in cold climates than in warm. In fact, heat which expands the cutaneous system increases the action of it at the expense of that of the glands, and reciprocally cold which contracts it, by preventing the constant exhalation that is going on there, forces the glandular system to supply this action. Hence why the same fluid, introduced into the economy, goes out with the urine in winter and with the sweat in summer; why, if we wish to produce an immediate discharge of urine in summer, it is necessary to suppress the perspiration by the sudden application of cold to the surface of the skin, by descending into a cellar, or some other subterraneous place; so that in summer we can, after digestion, make the product of the fluids pass off with the urine or the sweat, according to the temperature of the atmosphere in which we digest; why teas and diuretics forbid the use of each other, and why a physician who should employ them at the same time would know but little of the laws of our economy; why most of the diseases that are attended with an immoderate discharge of the secreted fluids, are almost always characterized by a diminution of the ex-

haled fluids ; why in some seasons diseases have a greater tendency to be characterized by sweats, and in others by urinary, mucous evacuations, &c. It is to the greater degree of the vital activity of the glandular system in the winter, that must then be referred the frequency of catarrhs, diseases most of which suppose an unnatural increase of its action, the greater facility with which the kidneys are influenced by cantharides, &c. Physicians should have these considerations particularly in view in their treatment. It is necessary to act more upon the glandular system in winter, and the cutaneous in summer, because each system is as much more disposed to answer to the excitements made upon it, as it actually is in greater activity.

Fifth Character. Influence of Sex upon Glandular Life.

Is the life of the glandular system more active in man than in woman? As it respects the glands destined to digestion, the secretion of the tears, the evacuation of urine, &c. there is but little difference in the two sexes. As to genital glands, man has testicles and the prostate ; woman has mammæ, so that in this respect they seem to be equal. Observe however that the influence of the first upon the economy, is much greater than that of the second. It is from the womb that go forth in woman the irradiations which correspond with those which the testicles send to all the other organs.

ARTICLE FOURTH.

DEVELOPMENT OF THE GLANDULAR SYSTEM.

I. *State of this System in the Fœtus.*

Though the secretions are not active in the fœtus, the glandular system is in general much developed. All the salivary glands and the pancreas are larger in proportion than afterwards; the liver is enormous; and the kidneys have a size much greater in proportion than they have in the adult. The same probably is true of the mucous glands, though I have not made any very precise researches upon this point. The form is different in many; the kidney for example is evidently uneven, whilst afterwards its surface is almost smooth. The colour is not the same; this is particularly striking in the salivary and lachrymal glands. These glands which are white in the adult, have in the fœtus an extreme redness which they lose by washing, which is not owing to the blood circulating in their vessels, though there is much of it in their vessels, but it is really inherent in their texture. This colour is never as great in the pancreas, though its texture is nearly the same. The texture of the glands is extremely soft and delicate at this age, which is the case with all the parts. They are divided and yield with great ease, and their vessels, which are large, carry into them a very great quantity of fluid.

Then they are, if we may so say, in a state corresponding with that of remission in the adult; they secrete even less fluid, though they appear however to be in constant

action. In fact, all the reservoirs would be insufficient to contain their fluids, if in a given time, as much flowed from them as after birth. Is this because the black blood, which then enters their parenchyma, is unfit to furnish the materials of the secretions? This may have an influence, and I have elsewhere imagined it, from the circumstance that this blood is unable to support many other functions. But the principal reason appears to me to be, that in the fœtus the nutritive motion of composition predominates evidently over that of decomposition, which is very inconsiderable. Almost every thing which arrives in the organs remains in them and continues to furnish the materials of the rapid growth which is then taking place in the body; now, the secretions being principally destined to carry off the residue of nutrition, must then be very inactive.

Besides, digestion does not introduce into the blood any of those principles which, being useless to nutrition, must on this account go out as they entered, that is to say without making a part of our organs; such are for example most of the drinks, which only pass into the mass of blood, and go out immediately with the urine.

The glands of the fœtus are then like the brain at that age; though much developed, they remain inactive; they are in the expectation of action.

II. *State of the Glandular System during Growth.*

At birth, the glandular system increases suddenly in energy; it takes a life which until then was foreign to it, and begins to pour out more fluid. It owes this change, 1st, to the difference of the blood which enters it, and which till then black and consequently venous, then becomes red and charged with principles that are new to it; 2d, to the general and sudden excitement carried to the extremity of all the excretories, by the aliments to those which open upon the canal that extends from the

mouth to the anus, by the air to the mucous ducts of the bronchial and pituitary surfaces and to the lachrymal gland, by the various frictions of the extremity of the glans penis and even by the air which acts also upon it, to the kidneys and the bladder.

All the glands are so much the more sensible to this sudden excitement, as they are unaccustomed to it. Their sensibility, heretofore torpid, is roused; they feel the contact of the blood which enters them and which till then had made only a feeble impression upon them. This sensation is so much the more acute, as on the one hand the organic sensibility of the glands becomes more evident, and as on the other the red blood is a more powerful stimulus than the black; for, as I have already had occasion to observe, the blood that arrives in an organ produces two effects in it, one of which is to excite it, either by the motion it communicates, or by the contact of the principles it contains, and the other is to furnish materials for the different functions, as for exhalation, secretion, nutrition, &c. The first effect is common to all the organs which the blood enters; the second is peculiar to each.

I would observe however that many of the secretions are much less active during the first years, than they are afterwards; such are those of the salivary glands, the liver, &c. The kidneys being destined to throw out the residue of digestion, as much and more often than that of nutrition, are in a state of activity in proportion to that of the first function. The infant often passes urine, as he frequently voids excrements. It is not because many substances, returning from the organs which they have nourished, present themselves to the kidneys, to be thrown out by this part.

The affections of the glandular system are not the predominant ones in early age. 1st. It is not the parotids that are enlarged in the frequent swellings that take place

in their neighbourhood, but it is almost always the lymphatic glands. 2d. We know that an excessive flow of bile, and the affections which arise from it, are then very rare. 3d. All the secretions relating to generation are absolutely nothing. 4th. In the same proportion in which the organic affections of the liver and the kidneys are common in the adult, are they rare in the infant. Then it is in what are improperly called lymphatic glands, in the brain, &c. that the morbid anatomist finds materials for his researches; for observe that the organs which are particularly in action in one age, are those which are most often attacked by acute and chronic diseases at that age, and that on the contrary they seem to forget those in which but little is done. 5th. Surgeons know that sarcoceles, hydroceles by effusion, varicoceles and all the diseases of the testicles are as rare before the period of puberty, when nutrition only is going on in these glands, as they are common in the subsequent years.

It appears that it is the mucous glands which are then the most commonly affected and are consequently in the greatest activity. The lachrymal glands are also very frequently in action. The infant weeps more often than the adult; we might say that all the passions which agitate this age have but one uniform mode of expression, and this mode is weeping. If the infant suffers, if he is jealous or frightened he weeps; if he is furious, he weeps because he is not very strong. This influence of the passions upon the lachrymal gland in the early years, seems to take place at the expense of the influence exerted upon the other glands. It is rare that fear or fright give to infants a sudden jaundice, or that they excite bilious secretions. At this age they do not pass water and void their excrements from fright as often as in the after ages; they have not the spasmodic vomitings that are so frequently occasioned by the passions of the adult; they do not become pale or red as much in anger; thus the coun-

tenance is not to the same extent the moveable picture upon which is painted the emotions of the mind. The eye does not sparkle in anger and is not expressive in friendship. It is the lachrymal gland which then most often serves in the face, for the expression of the passions. Observe that this expression is that of weakness and want of power, it is that of woman, who resembles the infant in so many phenomena. The feeble stag opposes his tears to the dogs, who seize upon him to devour him.

The glandular texture remains for a long time soft and delicate in the infant. At birth and in the fœtus, neither the liver nor the kidneys have the singular property of hardening by boiling. They remain during this experiment very tender and yield easily to the least impression. If the boiling be ever so long continued, they do not lose this character, which is gradually weakened as we advance in age, and which at this period makes the glands fit for some uses in our kitchens to which they are not so proper in the adult.

III. *State of the Glandular System after Growth.*

Puberty commences about the period that growth finishes. A gland till then inactive in man, enters suddenly into activity. The prostate follows it in its development. In woman the breasts swell, separate, and acquire in a short time a size which they would not have done in many years, if they had grown according to the same laws as in the preceding state. The other glands, far from being weakened, in proportion as these become stronger, increase their action also; they become stronger, and gradually lose the softness that characterized them in infancy; they moreover grow harder.

Till then composition had predominated over decomposition in the general nutritive motion. Then almost as many substances are constantly thrown from each organ,

as enter its interior to nourish it. Now as the glands are the great emunctories which throw out the residue of nutrition, they then pour out more fluids in proportion than before.

During youth it is the genital glands which predominate over the others; they seem to be a centre whence go irradiations that animate the whole machine. We might say most often that they are, in the mechanism of our moral actions, the spring which puts every thing in motion.

As we recede from youth, the influence of the genital glands becomes weaker, because they are in less activity. Towards the thirty-sixth or fortieth year, it is especially the glands destined to digestion which predominate over the others, and among these the liver in particular seems to be in activity. Then the bilious affections are predominant; then the passions to which the bilious temperament seems to dispose us, more frequently agitate the mind. Ambition, hatred and jealousy are often the sad attendants of this age. These passions are then more durable. The levity of youth and the passions arising from the influence of the genital glands, which predominate at this age, had for a time suppressed these, or rather had prevented them from being developed. Then they remain alone, the others having escaped in smoke with the fire of youth. Then also the influence of the lively emotions of the mind affects especially the glands and the abdominal viscera. Then is felt that contraction at the epigastric region, the painful effect of the bad passions; jaundice occasioned by sorrow is then more frequent.

This age is that of the organic affections of the glands, of all the numerous changes of texture, of all the excrescences which destroying as it were the nature of these organs, transform them into bodies of a different texture. In infancy, leucophlegmasia is most often produced by an engorgement of those lymphatic bunches that are called

glands, which resembles tabes mesenterica, the engorgement of the bronchial glands, &c. In the adult on the contrary, it is with the diseases of the liver, of the spleen, of the kidneys, that it is most often seen.

IV. *State of the Glandular System in Old Age.*

In old age, the glands become more firm and hard. Before that period even, the glandular system of animals ceases to be used at our tables. The liver, the kidneys, the spleen, &c. are mixed with the fleshy texture in common boiled meat, only to communicate to it some salts, some savoury principles that are foreign to this texture. They are not eaten, or at least they are not agreeable to the taste. The lungs which contain so great a quantity of mucous glands, do not afford a very digestible aliment except those of the calf; those of the ox are not brought to our tables, especially when the animal is old. I would observe upon this subject that the muscular and glandular systems are in an inverse order as it respects digestion, at least in the stewed state to which they are reduced for nourishment. In fact, the glandular system has not an agreeable taste and is not very digestible except in young animals, whilst at this age the muscular is insipid, and does not become savoury food till towards the middle of life.

In extreme old age, the colour of the glands changes less than that of most of the other organs. We find the liver, the kidneys, &c. almost as full of blood as in the adult; they are as red, whilst the muscles pale and colourless announce by their appearance that but little blood enters them at the latter periods of life. We might say that this fluid first abandons the skin and the muscles of animal life which in the trunk are subjacent to it, and which in the extremities are found very distant from the heart, or at least that it diminishes much in the two sys-

tems, and is concentrated in the organs in the neighbourhood of the heart; thus the secretions are still very abundant in old people, whilst the muscular, nervous forces, &c. are considerably weakened. The kidneys still secrete much urine; the liver pours out much bile, though this gland loses in part the kind of predominance it exercised in the economy towards the fortieth year. We know that the very frequent catarrhs that then take place, indicate an increase of action in the mucous glands. The functions of the testicles and mammæ have long since ceased.

The activity of the glands remaining in exercise, appears to be owing to two causes. 1st. The decomposition being very great at this age, many substances are presented to the glands to be thrown out. An old person decreases by a phenomenon opposite to the rapid growth of the fœtus, in which the glandular system throws out scarcely any thing from the economy. 2d. The skin having the horny hardness and being contracted, ceasing in part to be an emunctory of the products of decomposition, the glands supply the place of these functions. The cutaneous and glandular systems are then in the same relation as in winter and in cold countries, in which, we have seen, that the second constantly supplies the place of the first.

In general, the glandular system is one of those in which life is the most slowly extinguished. In the dead bodies of old people we find the bile still filling the gall-bladder, the bladder full of urine, &c. All the glands when compressed, the prostate itself, permit a large quantity of fluid to escape from their excretories. I have even observed that in this compression, we uniformly press out more fluid in an old subject than in a young one. The older the animals are, the more their kidneys, as we know, preserve the urinous smell. The lungs, which abound so much in mucous surfaces and conse-

quently in mucous glands, are not withered and have not the horny hardening in old age; they perform their functions as regularly as in youth.

In general it is a very remarkable phenomenon that all the principal internal organs, the liver, the kidneys, the spleen, the heart, the lungs, &c. still preserve a very considerable vital force, whilst the sensitive and locomotive organs already almost exhausted, have broken in part the communications which connect the individual with the objects which surround him.

DERMOID SYSTEM.

ALL animals are covered with a more or less compact membrane, of a thickness in general proportioned to the size of their body, destined to defend the subjacent parts, to carry out a considerable portion of the residue of nutrition and digestion, and to place it in relation with external bodies. It is in man a sensitive boundary, placed at the extremity of the domain of his mind, where these bodies continually touch, for the purpose of establishing the relations of his animal life, and of thus connecting his existence with that of every thing which surrounds him. This covering is the *dermis* or skin. We shall call the whole of it the Dermoid System.

ARTICLE FIRST.

FORMS OF THE DERMOID SYSTEM.

The covering which forms this system, being proportioned to the parts that it covers, is applied to these parts, adapted to their great inequalities, and allows the largest external prominences to be visible, but conceals a great

number on account of their small size ; thus the appearance of the body stripped of skin differs very much from that with the skin on.

This covering everywhere continuous is reflected through different openings in the interior of the body and goes to give origin to the mucous system. The limits between the two systems are always marked by a reddish line ; within this line is the mucous system, without it the dermoid. Yet the demarcation is not as striking in the organization as in the colour. Both are confounded in an insensible manner. In the neighbourhood of these openings, of those of the face especially, the dermoid becomes more delicate. At the commencement of these openings, the mucous borrows more or less, as I have said, the characters of the first.

I. *External Surface of the Dermoid System.*

This surface, everywhere contiguous to the epidermis, is remarkable for the hairs which cover it, for the oily fluid which constantly lubricates it, for the sweat that is deposited on it, for the sense of feeling of which it is the seat and which the internal surface does not possess. We shall in this article consider only the external dermoid forms, without regard to these different objects.

We see upon this surface different kinds of folds.

1st. Some are owing to the subjacent muscles which, being intimately connected with the dermis, forming almost a part of it, wrinkle it when they contract. Such are the wrinkles on the forehead ; those in the form of rays which the orbicularis produces around the eye-lids, &c. ; those of which the cheeks are the seat, when the great and small zygomatic, &c. contract ; those which the orbicularis of the lips produces around the mouth, when it contracts it by diminishing its opening, &c. All these folds are owing to this, that on the one hand the skin cannot contract like the muscles, and that on the other it

is necessary that it should occupy less space in length at the instant these are shortened. They are of the same nature as those of which the mucous surfaces, that of the stomach in particular, become the seat in the contraction of the fleshy layer which is contiguous to them. Thus the direction of these folds is always perpendicular to that of the subjacent muscles whose fibres they cut at a right angle. We are accustomed to attach much importance to the existence of these wrinkles in the expression of the passions; no doubt because then they are strongly marked. In fact the breadth of the face of man makes it well adapted to their development, whilst that of animals is badly formed to produce them. Thus their eye, rather than the features of the face, is the moveable picture which is differently sketched at every instant by the various feelings of anger, hatred, jealousy, &c. The wrinkles of the human face contribute very much to the expression of the countenance, they compose in part the physiognomy, and mark its different shades.

The wrinkles of the scrotum are analogous, to these; they depend upon the contraction of the subjacent cellular texture, in which some fleshy fibres appear also to exist.

2d. There are other wrinkles which are owing also to the motions, but not to those of the subjacent muscles. There are those of the sole of the foot, and especially those of the palm of the hand. There is not there any sub-cutaneous muscle adhering to the skin, except the small palmar muscle, which has no agency in these wrinkles that are formed at the places where the skin is constantly folded in flexion. Thus there are many of them about all the articulations of the phalanges. In the palm of the hand, we see three principal ones, one at the base of the thumb, produced by the motion of opposition, another at the anterior part of the palm, occasioned by the flexion of the four last phalanges which are bent towards the thumb, and the third is found in the middle of

the palm. The dermis is folded between these depressed lines, in the motions in which the hand is hollowed. Many other small folds corresponding with less evident and less frequent motions, cut these at different angles.

On the back of the foot and hand, there are many wrinkles about each articulation of the phalanges, when they are extended. They disappear in flexion, and are owing to this, that nature, on account of the motions, has made the skin more loose at this place, and broader in proportion to the parts it covers. About most of the articulations, there are analogous folds, but they are much less evident, because the skin adheres less to the neighbouring parts. Upon the whole trunk, the arm, the fore-arm, the thigh and the leg, we see no depressions but those from the muscular prominences.

3d. There is a third species of wrinkles, or rather cutaneous impressions, which are not very evident, found especially on the sole of the foot and the palm of the hand and which we easily distinguish from the preceding: they are those which indicate the rows of the papillæ. The surface of the trunk presents hardly any thing similar.

4th. Finally, there are the wrinkles of old age, which are of a wholly different nature. The sub-cutaneous fat having in part disappeared, the skin becomes too large for the parts it covers; now as it has lost with age its contractility of texture, it does not contract, but folds in various directions. Thus where there was the most fat, as on the face, these wrinkles are the most evident, they resemble those that appear on the abdomen after several pregnancies, dropsy, &c. In young people, if emaciation takes place suddenly, the skin contracts, and no wrinkle is formed.

II. *Internal Surface of the Dermoid System.*

This surface answers everywhere to the cellular texture which is loose upon the trunk, the thighs, the arms.

&c. and which is condensed upon the cranium, the hand, &c. In most animals, a fleshy layer called panniculus, and of a form analogous to that which is almost everywhere subjacent to the mucous system of man, separates the skin from the other parts, and communicates to it various motions. In man, the dermoid system exhibits here and there traces of this internal muscle, as is observed in the platysma myoides, the occipito-frontalis and most of the muscles of the face. There is nothing similar on the trunk, extremities, &c. Man is as much inferior in this respect to most animals, as he is superior by the arrangement of his facial muscles. Thus observe that whilst in him all the passions are painted as it were upon the face, and the whole exterior of the trunk remains calm in these tempests of the mind, this exterior is convulsively agitated in animals. The mane of the lion becomes erect, the whole skin of the horse moves, a thousand different agitations animate the exterior of the trunk of animals, and make it a general picture on which is painted all that passes in the interior. You can determine from behind, in many animals, by seeing only their bodies, that they are agitated with passion ; cover the face of man, the curtain is drawn over the mirror of his mind ; thus almost all nations leave it uncovered. The physiognomy is in this respect, if we may so say, more generally spread over the exterior, in animals with a fleshy panniculus.

Besides the cellular texture, the dermis is almost everywhere subjacent to the muscles in the trunk ; but, foreign to the motions of these muscles, it receives no sensible influence from them. In the extremities it is found separated from the fleshy layers by aponeurotic expansions. Many vessels wind under it ; the great veins pass through its texture ; many arterial ramifications go upon its surface, and many nerves between these ramifications.

ARTICLE SECOND.

ORGANIZATION OF THE DERMOID SYSTEM.

I. *Texture peculiar to this Organization.*

This texture comprehends, 1st, the chorion; 2d, that which is called the reticular body; 3d, the papillæ. The chorion is the essential part of the dermis; it is that which determines its thickness and form. The reticular body appears to be but little distinct from it. The papillæ arise from it also, but are more evident.

Chorion.

The chorion is of a very variable thickness. 1st. In the head, that of the cranium and that of the face exhibit an opposite arrangement. The first is very thick and also dense and compact, which is owing especially to the numerous hairs that go through it. The second, everywhere fine and delicate, is particularly so upon the eyelids and the lips. 2d. The chorion of the trunk is posteriorly and all along the back, of a thickness almost double that of its anterior part, where it is nearly the same upon the neck, the chest and the abdomen. I would except however that of the penis, the scrotum, the great labia and the mammæ, in which its delicacy is greater than any where else. 3d. In the superior extremities it is nearly uniform upon the shoulders, the arm and the fore-arm; on the hand it increases a little in thickness and more in the palm than on the back. 4th. This thickness is generally much more evident on the thigh and the leg, where

there are more muscles, than on the arm or the fore-arm. On the foot, it increases as on the hand, less in the dorsal than in the plantar region, which is the thickest of all the parts of the dermoid system; which is owing principally in the natural state to the arrangement of its epidermis. We see from this, that though everywhere continuous, the chorion is very different in its different parts. The relation of its thickness with its functions is easily perceived on the hand, the foot, the cranium, &c. Elsewhere we cannot so well see the reason of these differences, which are notwithstanding as constant.

Woman has a chorion generally less thick than that of man; compared in all the regions, it exhibits in the two sexes a sensible difference; on the mammæ especially, it is much more delicate in woman. That of the great labia however is proportionally thicker than that of the scrotum.

In order to understand perfectly the intimate structure of the chorion, it is necessary to examine it at first on its internal surface, after having carefully separated it from the fatty cellular texture, to which this surface adheres more or less intimately. We see then that it is differently arranged according to the regions.

1st. On the sole of the foot and the palm of the hand, we observe an infinite number of white fibres, shining like aponeurotic fibres, which are detached from this internal surface, form upon it a kind of new layer, cross each other in all directions, leave between them, especially towards the heel many spaces of different sizes, that are filled with fat, separate more and more, and are finally lost in the sub-cutaneous texture, nearly as the fibres of the brachial aponeurosis insensibly disappear in the neighbouring cellular texture. Hence why when we dissect the palmar and plantar integuments, we experience the greatest difficulty in separating them entirely from the cellular texture which is interlaced with these fibres;

hence why also these surfaces have not, on the parts which they cover, the mobility which many others exhibit.

The density of the cellular texture contributes also something to this arrangement which is essential to the functions of the foot and the hand, which are designed to seize and grasp external bodies.

2d. The dermis of the superior and inferior extremities of the back, of the neck, of the thorax, of the abdomen, of the face even and consequently of almost all the body, is distinguished from the preceding, because the fibres are much less distinct, and are not lost in the cellular texture by being as it were confounded with it, whence arises a remarkable laxity of the skin of these parts, and the very great facility with which it is dissected; in a word because the spaces between these fibres are much more narrow. These spaces appear like an infinite number of holes irregularly placed at the side of each other, containing most of them small fatty parcels of the neighbouring texture, and exhibiting, when these small parcels have been carefully removed, very evident vacuities. The fibres which form them, are sufficiently near each other, to make you believe at first view, that it is a surface pierced with an infinite number of holes, that has been applied under the skin. On the contrary, on the hand and the foot, towards the heel especially, it is a true network the spaces of which are larger than the fibres that form them; this is the reverse here. Be that as it may, these spaces in the internal surface of the chorion are very favourable to the action of tannin which penetrates the texture infinitely better from this side than from the opposite, because it insinuates itself into these numerous openings. I have had occasion to observe it in the human chorion which I have had tanned for the purpose. Chaptal has observed that the epidermis is a real obstacle to the action of tannin, and that on this account scraping is

a preliminary operation essential to tanning, since it allows the skin to be penetrated on both sides; but even when thus scraped, it receives the tannin much more easily on the side of the flesh than on the opposite one.

3d. The chorion of the back of the hand and the foot, as well as that of the forehead does not exhibit these numerous openings on its internal surface; it is smooth and white, especially when it has been macerated a little. It is precisely the same as that of the scrotum, the prepuce and even the great labia. The texture of it is more compact, no space is left in it, so that though more delicate than that of the extremities and the trunk, it contains almost as much substance. As to the chorion corresponding to the hair and the beard, we see in it only the openings necessary for the passage of the hairs, and which are wholly different from those of which I spoke just now, which form real culs-de-sac, and do not pierce through the chorion.

Hence the internal face of the dermoid chorion exhibits three very distinct modifications. The first and last are seen to a small extent, whilst the second is almost general, with some differences however in the trunk, the extremities and the head. Besides, these modifications do not suppose a diversity of nature, but only of forms. Much separated and arranged in fibres in the first, the dermoid texture is compact and condensed a little in the second, and by this condensation renders the spaces less distinct. But there is a means of seeing them everywhere very well, where there is the least trace of them, and this is by maceration. This means also shows the dermoid texture best. In fact, when the skin has remained for some time in water, it softens, the fibres of its chorion separate, and their interstices become more distinct; then we see that the spaces exist not only on the internal surface, but that they extend into its texture which appears to be truly like a sieve in its whole thick-

ness, so numerous are the spaces arising from the interlacing of the fibres.

These spaces do not terminate in culs-de-sac towards the external surface; they open upon this surface by many foramina which are very evident in a skin that has been macerated for a month or two, and which, in the ordinary state are almost imperceptible in some subjects, and very visible in others. Besides, in order to see them it is necessary to remove the epidermis; now as with the view of producing this effect immediately we commonly employ the action of boiling water or fire, the dermoid texture by this means acquires the horny hardening, and they become much less apparent, whereas maceration not only does not produce horny hardening of the skin, but it expands and dilates it, which renders these foramina very evident. In some parts of the skin and in certain subjects, we might then introduce the head of a pin into them; in others they are less evident. These foramina never pierce the dermis perpendicularly, all open obliquely to its surface; so that a perpendicular pressure tends to close them and bring their parietes in contact. I cannot compare their termination better than to that of the ureters in the bladder; hence why the hairs which go through them are never perpendicular, but oblique to the skin. We speak incorrectly when we say that the hairs are planted obliquely; their insertion in the bulb is perpendicular; it is in their passage through the chorion that they change direction.

Besides, these foramina are not vessels, but mere communications from the interior to the exterior through which pass the hairs, the exhalants, the absorbents, the blood-vessels and the nerves which go to the surface of the dermis; thus the subjacent spaces are only cells in which are contained the vessels of the glands and of the cellular texture. The dermoid texture should then be considered as a real net-work, as a kind of cellular tex-

ture, the cells of which very evident within, become less so on the exterior surface, with which all communicate to transmit to it different organs. The chorion is then the outline, the frame, if I may so say, of the cutaneous organ. It serves to lodge in its spaces, all the other parts which enter into the structure of this organ, and contributes to give them the form they are to have, but is wholly foreign to them.

What is the nature of this texture, which enters especially into the composition of the cutaneous chorion? I know not; but I think it has much analogy with the texture of the fibrous system; the following considerations support this analogy. 1st. On the heel, where the dermoid texture has the fibrous form of the irregular ligaments, it would be almost impossible to distinguish it from it, so uniform is the external appearance; it has the same resistance and density; the same sensation is experienced when it is cut with the bistoury. 2d. The dermoid texture becomes yellow and transparent like the fibrous by stewing. 3d. It melts gradually like it into gelatine. 4th. Like it, except the tendons however, it strongly resists maceration. 5th. Sometimes these two textures are identified; for example, the annular ligaments of the wrist evidently send elongations to the neighbouring dermoid texture. 6th. This texture can serve, like the fibrous, for the insertion of muscles; we see it in the face, where many of the fibres of the orbicularis of the lips and the eyelids, and almost all those of the eyebrows, find real tendons in the fibres of the dermoid texture. There is the same arrangement in the cutaneous palmar muscles.

All these considerations evidently establish many relations between the dermoid and fibrous textures. Yet they are far from being the same. To be convinced of this it is sufficient to observe how much their mode of sensibility differs, and how different also are their diseases; it seems

at first as if there was no analogy between them in this double relation. Yet the line of demarcation is by no means as great as it appears to be. In fact the acute sensibility of the skin is not seated precisely in this white texture, which is interwoven so as to leave between its meshes the spaces of which we have spoken, and which we see especially on the surface adhering to this organ. The experiment mentioned in the article on the mucous system, and in which I irritated the cutaneous organ from within outwards, evidently proves it. It is the surface on which the papillæ are found that especially exhibits this vital property.

On the other hand morbid anatomy proves that the internal surface of the dermis, in which are especially found the texture and the spaces of which we have spoken, is entirely free from most cutaneous eruptions. This is no doubt true as it respects the small pox, the itch and many species of herpes; I have satisfied myself of it as to the vaccine vesicles, the miliary eruption, &c. &c. It is certain that in erysipelas, the external surface only of the chorion is coloured by the blood which enters the exhalants; thus the slightest pressure, causing the blood to flow back, produces a sudden whiteness which soon disappears by the return of the blood into the exhalants. It is this which forms the essential difference between simple erysipelas and phlegmon, in which not only the external face of the chorion, but its whole texture and the subjacent cellular one are inflamed. In measles and scarlatina, the redness is also very evidently superficial. These phenomena accord with those of injections; for if they succeed at all in children, the skin of the face and less frequently that of the other parts, becomes almost entirely black. Now this blackness is much more evident on the external than the internal surface of the skin, no doubt because more exhalants are found in the first than in the second, which the arterial trunks only traverse.

The preceding considerations evidently prove that the texture of the internal surface of the chorion, and even that of its interior, have a vital activity much less than that of the external surface; that this texture is disconnected with all the great phenomena which take place upon the skin, with those especially which relate to the sensations and the circulation; that it is in the papillæ that the first are seated and in the reticular body the second; and that it is almost passive in nearly all the periods of activity of this double portion of the dermis. Its functions, like those of the fibrous texture, suppose it to be almost always in this passive state; they are only to defend the body and to protect it from the action of external bodies. It is this which forms our real covering; thus its properties are well adapted to this use. Its resistance is extreme. It requires very considerable weight to tear very narrow strips of chorion, when it is suspended from them; drawn in various directions, these strips are broken also with much difficulty.

Yet this resistance is much less than when tannin is combined with the chorion. We know that when thus prepared, this portion of the skin affords the strongest strings we have in the arts. I know but two textures in the animal economy, which unite to such an extent suppleness and resistance; these are this and the fibrous texture; and this is a new character which approximates them. We have seen that it requires a very considerable weight to break a tendon, a strip of aponeurosis, or a ligament taken from a dead body. The muscular, nervous, arterial, venous, cellular textures, &c. yield infinitely more easily. If the dermoid texture had less extensibility, it might advantageously supply the place of the tendons, the ligaments, &c. in the structure of the body.

Since the chorion is foreign to almost all the sensitive and morbid phenomena of the skin, let us inquire then in what part of the dermis these phenomena are seated.

These parts exist very evidently on the external surface; now we find on this surface, 1st, what is called the reticular body; 2d, the papillæ.

Of the Reticular Body.

Most authors have considered the reticular body as a kind of layer applied to the external face of the skin between the chorion and the epidermis, pierced with an infinite number of openings through which the papillæ pass. I do not know how we can demonstrate this layer, which escapes according to the opinion of most of them, when the epidermis is detached. In order to see it I have employed a great many means, but no one has succeeded. 1st. Such is the adhesion of the epidermis to the skin, that in a sound state we can hardly separate them without injuring one or the other. Yet with the greatest precaution we see nothing mucous on the chorion when it is laid bare. 2d. A portion of skin cut longitudinally, especially from the foot where the epidermis is very thick, allows us to see very distinctly on the divided edge the boundaries of this and of the chorion; now nothing escapes from about the line which separates them. 3d. In ebullition in which the epidermis has been removed, nothing remains upon the internal surface, nor upon the chorion. 4th. Maceration and putrefaction, the latter especially, produce upon the chorion a kind of glutinous layer the instant the epidermis is removed. But this layer is entirely the product of decomposition. Nothing similar is met with in the ordinary state.

I believe, from all these considerations, that there is not a substance deposited by the vessels upon the surface of the chorion, extravasated, stagnant upon this surface, and representing there a layer in the sense in which Malpighi understood it. I believe that we ought to understand by the reticular body, a net-work of extremely fine vessels, whose trunks already very delicate, after

having passed through the numerous pores with which the chorion is perforated, come and ramify upon its surface, and contain different kinds of fluids.

The existence of this vascular net-work is placed beyond a doubt by fine injections which change the colour of the skin entirely externally, without altering it much within. This is, as I have observed, the principal seat of the numerous eruptions most of which are really foreign to the cutaneous chorion.

We may then consider the reticular body as a general capillary system, surrounding the cutaneous organ, and forming with the papillæ a layer between the chorion and the epidermis. This system contains in most men, only white fluids. In negroes, these fluids are black. They have an intermediate tinge in the tawny nations. We know how much the shades vary in the human race. Hence the colouring of the skin resembles nearly that of the hairs, which evidently depends upon the substance existing in their capillary tubes; it is analogous to that of the marks at birth, that are commonly called nævi materni, and in which we never see a layer of fluids extravasated between the epidermis and the chorion.

Moreover, I think we know but little as yet concerning this substance, which fills a part of the external capillary system. It does not circulate in it, but appears to remain there till another replaces it. When we examine the skin of a negro, we see a black teint, and that is all. In maceration I have observed that this teint is sometimes removed with the epidermis, and that it sometimes remains adhering to the chorion. It is very evidently foreign to both, since both have the same colour in whites as in blacks. It is never reproduced, after it has been removed; for cicatrices are white in all people.

Is there in white people a white substance which, remaining in the external capillary system, corresponds to that of negroes, or does the colour of their skin depend

only upon the epidermis and chorion? I have been tempted to believe that they also have a colouring substance, since the long-continued action of a powerful sun evidently blackens them. This circumstance has even made me believe that whiteness is natural to all men, and that there was but one primitive race which has degenerated according to different climates.

But in order to be convinced of the diversity of races, it is sufficient to observe, 1st, that the teint of the skin is but one of the characters which distinguish each race, and that many others are always united to it. The nature and form of the hair, the thickness of the lips and the nose, the width of the forehead, the degree of inclination of the facial angle, the whole appearance of the face, &c. are constant attributes which indicate a general modification in the organization, and not merely a difference of the dermoid system. 2d. White people become tawny in hot countries; but they never acquire the teint of the people of the country. 3d. Removed to cold countries in early age, or even born in them, the blacks always remain so; their shade hardly changes at all from generation to generation. 4th. Colour by no means follows temperature exactly; we see many varieties in the shades of people who live under the same degree of latitude, &c.

Every thing proves then that the colour of the skin is but an insulated attribute of the different human races, though it is that which is most striking to our senses, and that we should not attach to it a greater importance than to many others which are drawn from the stature, which is oftentimes very small, as in the Laplanders, from the broad and flat face, as in the Chinese, from the dimensions of the chest, of the pelvis, the extremities, &c. It is from the differences of the whole, and not from those of an insulated part, that the lines of demarcation should be made which separate the races. The European face and forms are in general the type with which we compare the

exterior of the other nations. The ugliness or beauty of the human races are, in our way of considering it, measured by the distance which separates these races from ours. Such is in fact the force of habit with us, that we rarely judge in an absolute manner, and that every object which is much removed from those to which we are accustomed, is disagreeable to us and sometimes even disgusting.

Besides, the colouring matter of the cutaneous reticular body is more interesting to the naturalist than to the physician. What should particularly arrest the attention of the latter is the portion of the capillary system exterior to the skin in which the fluids circulate. In fact, besides the portion which is the seat of colour, there is evidently another that the white fluids constantly pervade, in which they are moved with more or less rapidity, and in which they continually succeed each other. It is from this portion that the exhalant pores arise which furnish the sweat; it is this vascular net-work which is the seat of erysipelas and of all the cutaneous eruptions that are foreign to the chorion.

The blood does not penetrate it in an ordinary state, but a thousand causes can at every instant fill it with this fluid. Rub the skin briskly, and it reddens in a moment. If an irritant is applied to it, whether it acts mechanically like nettles, the appendices of which penetrate the epidermis, or exerts a chemical action, like the frictions with ammonia, or the action of fire when a portion of skin is held too near it, instantly the sensibility of this vascular net-work is raised; it invites into it the blood which it formerly repelled; every part of a surface reddens in proportion to the irritation. If passion acts powerfully upon the cheeks, immediately a sudden redness is evident in them. All rubefacients exhibit moreover a proof of the great tendency which the sensibility of the superficial capillary system of the dermis has to place

itself, if it be ever so little excited, in relation with the blood which in the ordinary state is foreign to it.

Vesicatories depend upon the same principle. Their first effect is to fill with blood the cutaneous capillary system, where they are applied, to produce in it a sudden erysipelas, and then to occasion a copious serous exhalation under the raised epidermis. They effect in a few hours what most cases of erysipelas do in many days; for we know that most of them terminate by vesicles which are raised above the skin. In burning, carried sufficiently far to be more than a rubefacient, and yet not so as to produce the horny hardening, there is also a sudden increase of exhalation under the raised epidermis. In general the production of every cutaneous bladder is always preceded by an inflammation of the external surface of the skin. This phenomenon is not exclusively confined to this system. We have seen the serous, as soon as it is laid bare and irritated considerably, redden in a short time by the passage of the blood into its exhalants; which constitutes an inflammation to which often succeeds a copious exhalation of milky or other kind of serum. This exhalation does not remain upon the surface, and does not form vesicles there, because it has no epidermis; this is the only difference between these phenomena, which at first view do not appear to be the same in the serous and cutaneous systems.

It is not only the irritation of the cutaneous organ which makes the blood pass into the external capillary system. Whenever the heart is powerfully excited and it accelerates the course of this fluid, it always tends to go into it; this is what is evidently seen, 1st, after violent running; 2d, in the hot period of a paroxysm of fever.

Upon this subject I will make a remark which appears to me to be very important; it is that the capillary system of the face is, more than that of all the other parts of the skin, exposed to be thus penetrated with blood.

1st. This is evident in the two cases of which I have just spoken, and in which the action of the heart is increased. 2d. In the passions, the skin remains the same in the other parts, whilst that of the face suddenly becomes pale or red. 3d. We know that physicians frequently examine the state of the facial capillary system, which is almost always affected by the state of the internal viscera, and is full of blood or empty, according as it is sympathetically influenced. 4th. In various kinds of asphyxia, in those especially produced by submersion, by the vapour of charcoal, by strangulation, &c. the face is uniformly of a violet colour from the passage of the black blood into its external capillary system, into which it is brought by the arteries. Oftentimes the neck and the upper part of the chest are also livid; but there is never a discoloration of the inferior parts. 5th. In many diseases, in which death takes place by a kind of asphyxia, because the lungs are the first interrupted, the dead bodies have a violet-coloured and swollen face; this may be easily observed by all who frequent dissecting rooms. There are a hundred subjects in which the head has this lividity, to one in which it is observed in the inferior parts. 6th. Most cases of apoplexy produce the same lividity of the face.

To what is this extreme susceptibility of the facial capillary system to admit the blood owing? Three things, I think, principally contribute to it. 1st. The course is already opened to this fluid, since the redness of the cheeks necessarily supposes its presence in them, it only increases in quantity; whereas when another part of the dermoid surface becomes red, all the blood which enters it is almost accidendal. 2d. The anatomical arrangement of the capillary system is more favourable to this passage there than elsewhere; for it appears that the communications of this system with the arteries of the chorion are more free. What proves this is, that in injections the face is coloured with great ease. There is undoubt-

edly no anatomist who has not been struck with this phenomenon, especially in children, in whom if the coarse injections of our dissecting rooms succeed at all, the face becomes wholly black, whilst the fluid penetrates but very little into the other parts of the cutaneous system. 3d. It appears that there is a greater sensibility in the face; in fact the same irritant brings blood there, which does not make it flow to any other place. For example, a blow equal to a box on the ear does not redden the skin of the arm, whilst it suddenly inflames the cheeks.

The blood disappears from the facial capillary system as it enters it; in an instant the passions will successively produce there the bright red of a paroxysm of fever, the whiteness of syncope and all the intermediate shades. It is even the extreme ease with which this fluid penetrates this system, that renders the face well adapted to serve as a kind of picture, which the passions paint by turns with a thousand shades, that are effaced, altered, modified and return again according to the state of the mind.

I would observe upon this subject that the passions have in the face three means of expression; 1st, the capillary system, a means wholly involuntary, and which often betrays what we wish to conceal; 2d, the muscular motion, which, by contracting or expanding the features, expresses the melancholy or gay emotions, and to which belongs as effects, the various wrinkles of which we have spoken; 3d, the state of the eye, an organ, which, as Buffon has remarked, not only receives the sensations, but also expresses the passions. The two last means are to a certain extent voluntary; we can at least disguise them; whereas we cannot deceive by the first. The actor imitates anger, joy, &c. because we can give these passions by contracting the eye-brows, by dilating the face in laughing, &c. But it is the rouge of the actress that imitates modest chastity; it is by removing this rouge that she imitates the paleness of fear, horror, &c.

I will add another essential observation in respect to the facial capillary system; it is that it appears that its tendency to receive blood, disposes it to become the more frequent seat of many affections. We know, 1st, that erysipelas is much more frequent in this than in other parts; 2d, that the variolous pustules are remarkably conspicuous here; 3d, that many eruptions are more abundant here than elsewhere.

From all that we have just said, it is evident that it is necessary to distinguish two portions in the capillary system exterior to the chorion. 1st. One is constantly filled with the colouring substance of the skin, a substance which appears to be stagnant like that of the hair of the head, and that of the hair of the body, which is subjected only to the slow and insensible motion of composition and decomposition and which never exhibits that sudden increase or diminution of which we have just spoken. 2d. The second is constantly pervaded by many fluids which continually succeed each other there, and which constantly escape by transpiration, and which are replaced by the blood, that insinuates itself into this portion of the capillary system. These two portions are entirely independent, and have probably no kind of communication.

It appears that at the instant of death there remains a certain quantity of the white fluids in the second portion of the exterior capillary system; the following experiment, which I have frequently made, proves it; by plunging a portion of skin into boiling water, and leaving it there an instant, the epidermis is raised up, not as a whole as in a blister, but in an infinite number of small vesicles which are formed suddenly on its surface, and which contain a serous fluid, that escapes as soon as we open these vesicles.

Papillæ.

We call by this name those small eminences that arise from the external surface of the chorion, and which,

piercing the capillary net-work of which we have just spoken, become by their extremities contiguous to the epidermis. These eminences are very evident in the palm of the hand and the sole of the foot, where they are regularly arranged, in the form of small curved striæ in different directions. We see them through the epidermis, notwithstanding its thickness in these places. But they are seen especially when this has been in any way removed, as by maceration, ebullition, &c. If we cut longitudinally a portion of the chorion of the foot, with its epidermis adhering to it, we see between them along the divided edge, a line in the form of a curved thread, which arises from these small eminences placed at the side of each other.

In some other parts of the skin, we distinguish the papillæ in a very evident manner; but in a great number, the epidermis being removed, we see only a surface, slightly uneven from some small eminences, especially towards the orifices through which the hairs and the vessels pass, but we do not discover those regularly arranged eminences, the papillæ properly so called.

We must not mistake for them the numerous and very evident prominences, which render the skin of some subjects extremely rough. These prominences are formed by small cellular, vascular or nervous bunches, by sebaceous glands, &c. which are found near the small openings by which the chorion opens under the epidermis, and usually transmits the hairs. These bunches, lodged in the small oblique canals which are terminated by these openings, raise the external side of them and thus form this prominence. The following very curious experiment proves this arrangement; when the skin is macerated for two or three months, or even less, on the one hand these little bunches in which there is almost always a little fat, are changed into that white, thick, unctuous matter, analogous to spermaceti, into which fat kept a

long time in water is always converted; and on the other, the foramina enlarging, as we have seen, and the skin changing into a kind of pulp, we can easily remove it all around these little prominences, and see that they are continued with the fat which fills the meshes of the subjacent chorion, and which is also changed into a hard matter.

Injections have evidently proved to me that there were vessels in these cellular bunches, and I have been convinced of it for some time past by the dissection of some subjects that died of scurvy, in whom the spots commenced by very small ecchymoses, similar as it were to flea-bites, and which occupied these little eminences. The petechiæ of adynamic fevers have a different appearance; but they belong also to an extravasation of blood in the cellular texture, occupying the small pores which open on the exterior of the chorion to transmit the vessels, the hairs, &c. The more prominent these eminences are, of which we have spoken, the more uneven is the skin. In general they are more frequent on the extremities and on the back, than on the anterior part of the trunk. In the extremities there are more of them in the direction of extension, than in that of flexion.

We attach the idea of a beautiful skin, to that in which these small tubercles are not found, and in which the chorion is united at its external surface. Women have commonly this last arrangement more evident than men. The epidermis which covers these eminences very often scales off at that place, especially from strong friction, which contributes still more to render the skin uneven, rough and harsh to the touch where they exist, which might induce a belief that they are formed by it, though it is always only accessory to them. Where it is very thick, as in the palm of the hand and the sole of the foot, it cannot be raised, and these small cutaneous tubercles are never seen. In the face where many vessels pass from within outwards, by the little pores of which we have

spoken, we meet with hardly any more of them. The papillæ scattered among these eminences, are in general very slightly apparent in the places where they exist.

All anatomists attribute to these last a nervous structure; they regard them as the termination of all the nerves that go to the skin, and which, according to them, are expanded to form these, after having first left their external covering. Some even say that they have traced filaments even into the papillæ; I confess that I have never been able to do it. In the ordinary state, the density of the chorion and the extreme delicacy of the filaments, are evidently an obstacle to it. In the state of long continued maceration, in which the chorion becomes pulpy and in which we might consequently trace these filaments, were it ever possible, it cannot be done. I do not however deny the texture attributed to the papillæ. The acute sensibility of the skin seems even to suppose it; but it is only analogy and not demonstration, which establishes this anatomical fact; indeed all the other senses, whose organs are so sensible, have the portion of them which receives the impression of bodies continuous with a nerve.

Action of different bodies upon the Dermoid Texture.

In most of the other textures, we have only considered this action in the dead body, because during life, these textures always removed from external bodies, cannot be influenced by them. Here we can regard it in a double relation, since the skin is incessantly in contact with almost all the bodies of nature.

Action of Light.

Light evidently acts upon the dermis. Removed from its influence, men are blanched, if we may so say, like

plants. Compare the inhabitant of a city, who is never exposed to the influence of the sun, with the peasant who constantly is, and you will see the difference. It appears that it is the light and not the heat which produces the effect of which I have already spoken; for individuals who live in a warm temperature, but removed from the solar light, become white like those of cold countries. Thus we know that some men who keep their chambers always very hot, are whiter than others who, living in a less hot atmosphere, are constantly exposed to the sun. We might remain forever in a bath of a temperature equal to the warmest seasons, and the skin would not blacken. Apartments for study which are warmed with stoves, and in which men remain as long as the labourer at his plough, are as warm as the atmosphere of summer, and yet the skin of those who occupy them never becomes darker. Besides an irresistible proof is that the clothing which does not prevent the action of caloric upon the skin, and which offers a barrier to the rays of light only, prevents the cutaneous colouring that takes place upon the parts which the light immediately strikes, as upon the hands, the face, &c.

I do not speak of the solar influence upon the vital forces of the skin, as in cases in which sun-strokes produce erysipelas, or as when light is employed medicinally to recall the life of a part; but it is only in relation to the dermoid texture that I consider its action.

Action of Caloric.

The action of caloric upon the skin exhibits very different phenomena, according to the degree of it that it is applied.

1st. A warm atmosphere expands the dermoid texture increases its action, and makes most of the fluids which form the residue of nutrition and digestion, pass off by the exhalants.

2d. When contracted by cold, this texture refuses to admit those fluids, which then go off principally by the urine.

3d. The insensible change from one to the other of these two states, does not disturb the functions. When this change is sudden, there are almost always alterations in different organs, because the fluids destined to pass out, cannot vary their direction as rapidly towards this or that organ, as the cutaneous excitement produced by the sudden changes from heat to cold.

4th. The skin resists a temperature much greater than that of the body; it opposes an insurmountable barrier to the external caloric, which tends to an equilibrium in animate as well as inanimate bodies. Thus whilst these last are penetrated with this fluid in a medium warmer than themselves, and soon acquire the temperature of this medium, living bodies remain at the same degree, how much greater soever the surrounding heat may be to their own. The curious experiments of the English physicians have placed this truth, as it respects man, beyond a doubt. It is unnecessary to give the detail of these well known experiments, in which the mercury was seen to descend in the thermometer, when the bulb was placed in the mouth and in which the skin became covered, in a heated room, with the aqueous vapours of the air, which the greater cold of the body condensed upon its surface. A slight attention to animals with cold blood, living in warm climates, proves the same thing. I will make one remarkable observation upon this point, it is, that most reptiles, whose temperature is much less than that of the mammalia and of birds, and who consequently are brought much nearer than them to the temperature of winter, cannot however support it. They become torpid and sleep in subterraneous places, the heat of which remains nearly uniform like that of cellars, and do not awake till the milder temperature of spring stimulates them.

5th. The skin, in very cold climates, seems to be on the other hand an obstacle which prevents the internal caloric from suddenly escaping and thus placing the body in equilibrium with the surrounding medium. This is evident in countries near the pole. Upon this subject an observation the reverse of the preceding can be made; it is that the cetaceous animals inhabit seas the temperature of which is most unlike their own. Whales are sought for especially in the latitudes of Greenland, Spitzbergen, &c. Why do fishes with warm blood delight in the frozen seas, whilst the amphibious animals with cold blood prefer the burning heat of the sun? I know not.

Let us observe that most of the internal organs when exposed in solutions of continuity, have not the faculty of preserving as well as the skin, a degree of independent temperature. They become cold or hot sooner than it as long as they remain healthy. The intestine brought out of the abdomen in the operation for hernia, a muscle laid bare, &c. &c. exhibit this phenomenon; thus in order to give them this faculty of having an independent temperature, nature inflames them, and they thus constantly preserve their heat, whatever may be that of the surrounding medium. The mucous surfaces next to the skin resist the surrounding temperature the most, as is seen in prolapsus of the rectum, in inversion of the anus, &c. This difference among the different systems is probably owing to that of their structure.

6th. When the action of caloric is carried to a very considerable extent, it begins to act upon the skin, and its effects are the more evident in proportion as it is the more intense. 1st. The slightest of these effects is to produce an evident redness, a kind of erysipelas; the caloric then acts like a simple rubefacient. 2d. The second is to redden the skin and then to produce vesicles on it. 3d. In the third there is a real horny hardening, a crisping of the fibres of the chorion which contract, like

those of all the animal textures exposed to too strong a degree of heat. 4th. In the fourth and last effect, the dermoid texture is burnt, blackened and reduced to mere carbon. These different degrees of burning arise only from different degrees of caloric. I would observe that in the two first effects, this fluid acts upon the vital forces, and that these two effects cannot consequently take place except during life. The two last are exerted only upon the texture of the organ; thus they take place after death precisely as before. Cooks often employ the horny hardness, to give to the skin a hardness and brittleness necessary in some kinds of cooking.

7th. Cold carried to a great degree acts also upon the cutaneous organ, and produces different effects, according to its intensity. The first of these effects is very analogous to the first effect of a slight degree of caloric. It consists of a kind of local inflammation. The tip of the nose, the ears and the fingers, the cheeks, &c. become red from a slight degree of cold. I have not accurately observed the other effects between this and the last, which consists in a sudden privation of life. But there is this difference between the gangrene that then takes place, and that produced by a high degree of caloric, that the blackness is sudden in this last, whereas it takes place only as a consequence in the other. Observe in fact that there is in gangrene two things which physicians do not sufficiently distinguish, 1st, the mortification of the part; 2d, its putrefaction. The mortification is always antecedent; it is produced by a thousand different causes; sometimes by the ligature of an artery, as in aneurism; sometimes by that of a nerve; often by violent inflammation; sometimes by a contusion, attrition, a bruise, &c. Whenever a part is dead in the midst of those which live, whatever may be the cause of its death, it becomes putrid precisely like a dead body, every part of which life has left. Putrefaction takes place then even sooner, because on the one

hand the natural heat of the body, and on the other the moisture of the surrounding parts, favour it remarkably. This putrefaction varies according to the state in which the part was at the instant of death. If much blood infiltrated it, as when inflammation destroys life, it quickly becomes putrid, blackens immediately and allows a fetid sanies to escape; this putrefaction is called moist. If there is but little blood in the part at the instant of death, its putrefaction is less sudden; it first putrifies, then blackens, and allows but little sanies to escape; this is the dry gangrene. Thus in a dead body, if one part is much loaded with blood, as the head of those that have died of apoplexy, its putrefaction is much more rapid and moist than that of the parts in which this fluid is less abundant. In the gangrene which succeeds mortification produced by cold, there is often dryness of the part, because there was but little blood in it at death. How little many physicians know of the progress of nature in the employment of antiseptics, which they apply in the living economy, as upon flesh without life. Antiseptics are applied for one of two purposes, either to prevent the death of the part, or its putrefaction. 1st. If it is with the first intention, antiseptics should be varied. By untying the artery of a limb of an animal that has been tied, you will perform an antiseptic operation. Bleeding and emollient applications which lessen the violence of inflammation in a phlegmon, are antiseptics. A tonic as wine and all stimulants which excite the vital forces in a part in which they are languid after a bruise, are antiseptics. This word is then extremely improper when it is applied to medicines designed to prevent the mortification of the parts. Antiseptics are employed to prevent a dead part in the midst of living ones becoming putrid; some effect is obtained; thus by sprinkling cinchona, muriate of soda, or any neutral salt, by moistening a limb, a portion of skin, the ex-

tremity of the nose, &c. which is dead from any cause, the putrefaction will be arrested, as in a dead body upon which the same means are employed. But what will be the result of it? a little less fetor in the surrounding parts and less danger of their receiving the influence of the emanations of the dead part; but it is always necessary that this should come off; antiseptics will never bring it to life. Hence it is evident that these means should be considered in two points of view entirely different. The first prevent mortification, and vary remarkably though they are designed to effect the same object; thus our means of curing retention of urine are very variable, oftentimes opposite, according to the cause which tends to produce this retention. The others prevent putrefaction, without restoring the parts to life; now these are uniformly the same, whatever may have been the cause of the local death.

Action of the Air.

The air acts incessantly upon the cutaneous organ. In the ordinary state, it constantly removes from its surface the sweat that is exhaled from it. Fourcroy, who has paid particular attention to the solution of the transpired fluid by the surrounding air, appears to me to have allowed too much influence to this solution upon transpiration. In fact there are two very distinct things in this function: 1st, the action of the exhalants which throw out the fluid; 2d, the action of the air which dissolves and evaporates it. Now the first of these is wholly independent of the other. Whether the fluid is dissolved or not, more is still furnished by the exhalants. If the solution does not take place, the fluid accumulates upon the skin, which remains moist; but this moisture does not obstruct the exhalant pores and prevent new moisture from being added to it. A comparison will render this very evident. In the natural state, the serous fluids are constantly exhaled

and absorbed; the absorbents perform for them the functions of the air which dissolves the sweat; now, though these vessels cease to act, as in dropsies, the exhalants continue their action; there arises only a serous collection, which, though applied to the orifices of the exhalants, does not prevent them from pouring out more serum. The bladder in vain contains urine which presses upon the opening of the ureters, these ducts do not pour less into it. Though the mucous juices become stagnant on their respective surfaces, new juices are however poured upon these surfaces. So though the skin remains moist from the want of solution of the transpiration, more transpiration is nevertheless exhaled. Solution is a physical phenomenon wholly foreign to the vital phenomenon of exhalation. We transpire in a bath as well as in the air; only the fluid which arises from it is mixed with the water, instead of being reduced to vapour.

The moisture of the skin is owing to two causes wholly foreign to each other; 1st, to the increase of the fluid furnished by the cutaneous exhalants; now the action of these exhalants may be increased from three causes. First, every thing which accelerates the motion of the heart, as running, the paroxysm of acute fevers, &c. drives to the skin, as it is commonly expressed. In the second place, every thing which tends to relax and expand the cutaneous organ by a direct action exerted upon it by the surrounding bodies, increases also the action of these exhalants, as in the great heat of summer, as in a bath and after coming out, as in a heated room, &c. In the third place, the action of the skin is in many cases sympathetically increased. Here may be classed the sweats of phthisis of which the lungs are the source; those of fear, which depend upon a sudden affection of an epigastric organ; those of many acute diseases, &c. Now in all these cases, however active the solution by the air may be, the skin will be constantly moist, because there is

thrown out upon it more fluid than the air can dissolve. Thus in catarrhs of the lungs, in which more mucous juices are thrown into the bronchia than the air can remove, it is absolutely necessary that there should be cough and expectoration to carry off the remainder.

2d. There are cases in which the moisture of the skin arises from the solution not being sufficient. This is what takes place in the moisture of the bed in which the air is not changed, in damp weather, &c. There is not then more fluid exhaled; but the ordinary fluid becomes evident, because it is not dissolved. It is under this point of view that we must consider the action of the air upon the cutaneous organ which transpires. It carries off nothing in this organ; it has no real action upon it; it takes only what its vessels throw off. Solution is merely accessory, it is always subsequent to exhalation, and has no relation with it. In the same day, in which the temperature has remained the same, the skin is often dry, moist, humid and even wet with sweat. If the air acts upon transpiration, it is by contracting or relaxing the exhalants, and not by dissolving what they throw out. If the skin formed a sac without an opening, like the serous surfaces, transpiration would go on though it was removed from the contact of the air, the same as if in contact with it. Why in fact should not that take place there, which does upon these surfaces?

If we consider the action of the air upon the skin of the dead body, we see that it produces two different effects, according to the state of the body. If the air penetrates the skin on all sides, it dries it, and it then acquires a sort of transparency, like the fibrous organs, unless a large quantity of blood had been accumulated in it at the moment of death, in which case it becomes black or of a deep brown. Thus dried, 1st, it is firm and resisting, but can be bent in various directions without breaking, as is the case with many textures thus dried, as

the cartilaginous, the muscular, &c. &c. 2d. It is much less easily altered than most of the other textures in a dried state. 3d. It absorbs moisture less easily than them, though however when immersed for a long time in water, it finally resumes nearly its original colour and loses its transparency. 4th. It does not exhale a very disagreeable odour, like many of the other textures. Hence why the skins of animals, merely dried, are used in many of the arts; why some barbarous people make use of them for clothing, &c. The aponeuroses, and the mucous, serous and fibrous membranes could not be thus employed. It is to this also that must be attributed the little alteration that takes place in the exterior of mummies, which would never last for ages, if clothed with a fleshy or serous covering.

When the skin is left upon the dead body, or exposed to a moist air, it becomes putrid instead of drying. Then it takes at first a dull colour, then a green and finally a black one. It exhales a very great fetor, swells and thickens, because the gases which are disengaged there fill the cellular texture in its little spaces. A mucous covering is spread upon its external surface, which is deprived of its epidermis. Nothing similar to this covering is seen on the internal surface. Finally, when all the fluids it contains are evaporated, there remains a black residuum, very different from that which is left after combustion.

Action of Water.

This action during life, is relative either to the substances that are deposited on the surface of the skin, or to the cutaneous texture itself.

The sweat deposits incessantly upon the epidermis many substances, the principal of which are taken away by the air, but many being slightly soluble in it, as the salts for example, remain on its surface, and adhere to it

when not removed by friction. Mixed with the unctuous fluid which oozes out upon this surface, and with the different foreign particles that the air deposits there as everywhere else, these substances form upon the skin a deposit which cannot, like the transpiration, be carried off by solution. Now water removes all this deposit; hence why the use of baths is truly natural. All quadrupeds bathe themselves. All birds frequently plunge into the water; I do not speak of those for whom this fluid is as it were the element. It is a law imposed upon all species of animals whose skin throws out a considerable quantity of fluid. All the human races hitherto observed frequenty plunge into brooks, rivers, or lakes, along which they take up their abode. The countries that are well watered are those which animals prefer. They avoid those where this fluid is wanting, or in which it is only sufficient for their drink. We oppose nature in every thing in society. In our own, numerous classes hardly ever use a bath; thus you must seek especially in these classes for cutaneous diseases. We have seen that the mucous juices, remaining too long upon their surfaces, irritate and stimulate them and cause there various affections. Is it astonishing that the residuum of the cutaneous exhalation which the air does not remove, should occasion various alterations upon the skin? In summer, baths are more necessary, because as many excretions are taking place by the skin, more substances are deposited there. In winter, in which every thing passes off by the urine, the cutaneous surface becomes less dirty, and has less need of being cleansed. After severe diseases, in which there has been copious cutaneous evacuations, one or two baths terminate the treatment advantageously. Let us consider water then as acting as accessory to the air upon the skin, as removing from its surface substances which the first cannot dissolve, substances, which varying remarkably like those that compose the urine,

have presented the transpiratory fluids to chemists, sometimes as alkaline, sometimes as acid, oftentimes as containing salts, sometimes charged with odoriferous substances, &c. Water is the general vehicle; when it is evaporated, it leaves the substances that are not volatilized like it. It is on this account that dry frictions are also advantageous; they clean the exterior of the body.

As to the action of the bath upon the cutaneous texture, we know but little of it during life. They say in medicine that it softens, relaxes and unbends this texture; this is vague language to which no precise meaning is attached, and which is no doubt borrowed from the relaxation which the skin of dead bodies undergoes, or even tanned leather, when exposed to water. A bath acts upon the vital forces of the skin, raises or diminishes them, as I shall say; but it leaves its texture in the same state; it is only that of the epidermis which it alters, as we shall see.

Macerated in water of a moderate degree of temperature, in that of cellars for example which does not vary, the human skin softens, swells but little, becomes evidently whiter, and remains for a long time without experiencing any other alteration than that of a putrefaction infinitely less than that of the muscular, glandular, mucous textures, &c. subjected to the same experiment. This putrefaction, which removes the epidermis, appears to be much greater on the side nearest to this membrane; at the end of two or three months the skin loses but little of its consistence. It does not become pulpy as the tendons and muscles in this length of time when macerated; it does not become a fetid pulp till the end of three or four months. I have preserved some of it for eight months, which has still its primitive form, but which feels liquid under the fingers when pressed a little. In the half putrid state, the skin still preserves the faculty of crisping from the action of caloric; it moves about when placed

on burning coals, or when plunged into boiling water. When once reduced to a really putrid state it loses this property.

Exposed to ebullition, the dermoid texture when well separated from the cellular, furnishes less scum than the muscular, the glandular and the mucous ; it resembles in this respect the tendons, no doubt because being almost wholly gelatinous, it contains but little albumen. In the horny hardening that takes place a little before ebullition commences, it twists and then always becomes convex on the side of the epidermis, and concave on the opposite side ; and for this reason ; the fibres of the chorion in contracting by the horny hardening, are pressed against each other ; all the spaces which exist between them are effaced ; now, as these spaces are very large in the second direction, the dermoid texture necessarily becomes more contracted there, whilst in the first, the spaces hardly existing at all, every thing being almost solid, the fibres have less space to contract, they remain longer, and the surface continues larger. In the natural state the cavity of these spaces, being filled with cellular texture, increases the extent of the internal surface ; this space then disappearing, this surface becomes contracted.

The moment this kind of twisting takes place upon the skin, it is covered, as I have said, with an infinite number of vesicles filled with serum, and which are formed by the epidermis. As this membrane is very thick on the soles of the feet and the palms of the hands, it cannot contribute in those places to their formation, and we see nothing there similar to them. Yet by removing it from feet that have been boiled, I have observed that it contained between its layers many small vesicles, which were scarcely visible. I have not analyzed the water of these vesicles, but presume it is analogous to that of blisters. Besides a greater or less quantity of it is poured out, and the vesicles are consequently larger or smaller, according

to the state of the external capillary system at the instant of death.

By the horny hardening, the skin becomes hard, elastic, very resisting, thicker, but not so broad. It soon loses its semi-transparency and yellowish colour, like the boiled fibrous organs. Then the hardness it had acquired at the instant of the horny hardening is gradually lost; it softens, gives out much gelatine in the water in which it is boiled, does not lessen in size, but even increases in thickness. Every kind of fibre, vacant space and organization is then gone; it is a membranous mass, homogeneous in appearance, semi-transparent and gelatinous. In this soft state, it does not lose the elasticity it had acquired in the horny hardening, like the mucous, serous, cellular textures, &c. &c. The great quantity of gelatine it contains still preserves this property in it. The least motion that is communicated to it produces a general trembling, a sort of vibration of all its parts, exactly analogous to that of the various kinds of animal jellies, half coagulated, which vaccillate in the vessel from the least jar.

Finally, the ebullition still continuing, the gelatine is almost all dissolved, and there remains only a residuum like membrane and which disappears with great difficulty; it requires even a very long time for common boiling water to reduce the skin to this residuum. Such are the phenomena of the ebullition of the human skin as I have carefully observed them. Chemists have paid great attention to the dermoid texture of many other animals; they have formed different ideas of its nature; they have admitted that there are two substances in it; one fibrous and the other gelatinous. I refer to their works upon this point, particularly to the labours of Seguin, and the work of Fourcroy; for in general I do not relate what is detailed by others, it would be only a useless repetition.

Action of the Acids, the Alkalies and other Substances.

The sulphuric, nitric and muriatic acids act upon the skin, when in contact with it, as upon all the other animal substances. I have remarked however that their action is much slower, especially on the side of the epidermis, though this membrane may have been previously taken off. The first of these acids reduces it easily to a blackish pulp; the others bring it to a pulpy state with more difficulty, even when they are very little weakened; the oxy-muriatic acid produces hardly any effect upon it.

Some authors have said that the lapis infernalis produces the same phenomena on the dead as on the living body. I wrapped up in a piece of skin, as in a rag, many fragments of this substance, so that they were in contact with the epidermis; at the end of a day they were reduced to a kind of pap of a yellowish red, by the moisture which they had absorbed. The dermoid texture, crisped and contracted, had not been penetrated; it did not appear even to have been injured on the exterior. In general the action of the alkalies appears to be wholly different during life, and it varies even according to the different degrees of vitality. We know that flaccid and fungous flesh burns much less easily than that which is red and vigorous. It is the same with the acids. Never during life do they produce any thing analogous to that pulp of different colours according to the acids that are employed, which is always after death the result of their action.

We know that an alkaline solution, put in contact with the skin, produces a kind of unctuous and slippery feel, which is no doubt owing to the combination of the alkali with the oily deposit of the skin, from which arises a sort of soap.

I shall not speak of the tendency of the dermis to combine with tannin, nor of the phenomena of this combina-

tion; I should only be able to repeat what others have said upon this point. I will merely remark that it would be very important to try the effects of tannin on the large sub-cutaneous aponeuroses, the texture of which being essentially gelatinous has much analogy with that of the dermis, and which from their extent and delicacy might serve for uses to which the dermoid texture when tanned is less adapted. We know that the tanned skin is no longer what it was in the natural state, and that the substance with which it is then penetrated gives it an artificial consistence. If much tannin has been combined with it, it loses entirely the faculty of acquiring the horny hardness, and becomes brittle; whilst if but little of this substance is added to it, it preserves in part its suppleness and the property of crisping from the action of caloric. I would compare tanned skin to bone penetrated with the phosphate of lime, and that which is not tanned, to the cartilaginous parenchyma from which the acids have removed this phosphate.

II. *Parts common to the Organization of the Dermoid System. Cellular Texture.*

The whole dermis is penetrated with a large quantity of this texture. It is arranged in the following way; from the exterior of the sub-cutaneous cellular layer, an infinite number of elongations is detached which penetrate the contiguous spaces of the chorion, enter afterwards into those which are more exterior, and finally terminate in the numerous pores which transmit outwards the vessels, the nerves and the hairs, which have previously passed through this cellular texture. We can then consider the chorion as a kind of sponge, the spaces of which represent the interstices, and which the cellular texture penetrates on all sides; so that if it was possible to separate by dissection, these spaces from the cellular

texture, and the organs which are in it, there would be a kind of sieve pierced in all directions. Art cannot arrive at it but with difficulty on account of the delicacy of the parts; but that which is not done by dissection, nature often effects. In biles I have observed that all that which fills the interstices of the dermoid fibres disappears by suppuration, and that these fibres, separated besides by the swelling of the parts, exhibit truly the appearance of a sieve of which I have just spoken, when the fluid that moistens them is removed. The bile differs in fact from many other cutaneous eruptions, in this that it attacks the cellular texture of the spaces of the chorion, whilst they have their seat, as I have said, in the reticular body. I do not know any acute affection which attacks the chorion itself; all have their seat either on its surface, or in the cellular texture of its cells. Its dense and compact texture seems, like that of the aponeuroses, not able to be changed until a length of time. In elephantiasis I have seen this texture evidently disorganized.

M. Thillaye showed me portions of skin taken from a cemetery, in which every thing that filled the dermoid spaces had disappeared, and in which these spaces and their dried fibres formed a real membranous sponge through which the light could everywhere be seen. In this case the reverse of what is seen in long continued macerations had taken place, in which the fatty cellular texture, changed into a solid, white substance, preserves, as I have said, the form of the spaces which it filled, whilst the dermoid fibres reduced to the pulpy state, are easily removed. In the first case it is the mould only which is left; in the second it is the substance which is contained in it.

In chronic leucophlegmasia, the sub-cutaneous serum gradually extends along the cellular elongations of the spaces of the dermis, separates their fibres, consequently enlarges these spaces, and sometimes penetrates even to

the epidermis, which it breaks in different places, and through the crevices of which it escapes. In this case, there is not resolution of the skin into cellular texture, as it is called, but a separation of the dermoid fibres, which always remain.

I do not presume that the cellular texture of the chorion extends to its external surface, under the epidermis; for when this has been removed, fleshy granulations are not formed, now, in all the parts where the cellular texture is found, these granulations are produced, when the parts are laid bare.

Blood Vessels.

The arteries winding in the sub-cutaneous cellular texture, furnish an infinite number of small branches which are introduced with the cellular parcels into the most internal dermoid spaces, afterwards pass into those that are nearer, approximate by winding and anastomosing a thousand times through the spaces of the external surface of the chorion, finally go through the pores of this surface, and give rise to that external capillary net-work of which we have spoken in the article upon the reticular body, and to which in the ordinary state but very little red blood comes. In this course through the dermoid spaces, but few small arteries remain in the fibres of the chorion itself, as fine injections prove. These fibres resemble in this respect those of the aponeuroses through which many vessels pass, but which have but few belonging to their own texture.

The veins follow nearly the motion of the arteries, but in an inverse direction. After having passed through the dermoid spaces and the cellular texture which fills them, they go to the great sub-cutaneous trunks, which run a long course, form, as we have seen, a system wholly distinct by its position from that of the arteries and which can be often traced through the integuments. Not seen

in the natural state, the venous ramifications of the spaces of the chorion are considerably dilated in the subjacent cancerous tumours, and make the skin which covers these tumours appear to be marked with blue lines, which always grow larger as the tumour increases. Whenever there is a considerable distention of the cutaneous organ by an aneurism, pregnancy, dropsy, &c. this dilatation also takes place, provided the cause of the distention pursues a chronic course; for nothing similar is seen in acute affections, whatever swellings may have taken place, as in those consequent upon fractures, upon compound luxations, &c.

All the black blood formed in the skin goes into the general venous system; no portion belongs to the abdominal.

Nerves.

Their distribution is nearly the same as that of the blood vessels. Many very considerable branches, as different divisions of the musculo-cutaneous, the internal cutaneous, the lumbar, the saphena, the anterior tibial, the intercostals, the cervicals, &c. form a kind of sub-cutaneous nervous system, from which go all the branches that enter the dermis. These branches, in passing through the dermoid spaces with the arteries and the veins, appear to anastomose often together, go through the pores which terminate the spaces on the interior, and no doubt form the papillæ. Observe even that on the hand where the papillæ are very evident, there is, in proportion to the surface, many more sub-cutaneous nerves than any where else.

Absorbents.

Many absorbents creep under the skin; it is here that they can be the most easily studied. All the veins are surrounded with them; various fasciculi are observed in their

interstices; so that a layer of absorbents, arranged in the form of a continuous layer, seems to separate, in the extremities, the aponeurosis and the skin. There is no doubt that the origin of the most of these vessels exists in the chorion, that they carry to the blood the fat and the cellular lymph of its spaces, and the nutritive matter of its fibres. But is there a particular order of branches opening upon the surface of the epidermis to absorb in certain cases foreign substances? This question cannot be answered by anatomical inspection. But the following considerations appear to me to throw great light upon it.

1st. The sub-cutaneous absorbents, visible by injections, are too numerous in proportion for the mere purpose of carrying back the fat and serum of the neighbouring parts.

2d. There are many medicines which appear to be evidently absorbed; such are mercury in the venereal disease, various purgative and emetic substances, febrifuges even, as cinchona, which, when applied by friction, have produced their effects as well as if taken by the stomach; cantharides often act upon the kidneys, when the tincture is used as a liniment, narcotic substances sometimes occasion a weight in the head and drowsiness when they have been externally applied, &c. These different effects are well known and many authors have given examples of them.

3d. There is we know absorption of different kinds of virus, of that of hydrophobia, of the small-pox, of the venom of the viper, &c. an absorption, it is true, which rarely takes place when the epidermis is whole, but which uniformly does, when this being removed, the matter is found in contact with the external capillary net-work of which we have spoken. I would remark even that the different kinds of inoculation of the small-pox, of the vaccine disease, &c. evidently prove both the existence

and importance of this net-work, to which heretofore sufficient attention has not been paid. There are many contagious principles which are absorbed through the epidermis; such are those of the plague which the clothes communicate and those of different pestilential fevers which penetrate by the skin more than by respiration. I believe cutaneous absorptions from which diseases arise may be divided in the following way:

1st. Absorptions which take place through the epidermis, and which produce an effect	1st, local, as the itch, herpes, tinea capitis, &c. &c. 2d, general, as pestilential diseases, putrid fevers taken in an unhealthy place, &c. &c.
2d. Absorptions which take place only when the epidermis is removed, and from which arises an effect	1st, local, as the vaccine disease, the small-pox, &c. &c. 2d, general, as hydrophobia, the venom of the viper, a wound with an instrument impregnated with putrid matter, &c. &c.

We see by this table that the absorbents when charged with injurious substances, sometimes do not transmit them beyond the part and sometimes carry them to the blood, which conveys them to the different organs of the economy. Some authors have thought that in those cases in which the effects of the absorption become general, there is rather nervous action and sympathetic phenomena, than the transmission of an injurious matter into the circulation, and that consequently the solids take almost an exclusive part in these diseases. But to remove all doubt upon this point it is sufficient to observe, 1st, that, in the absorption of many contagious substances, for example, when from the puncture of the finger with a scalpel impregnated with putrid substances, a pain is produced, there is even a redness along the whole course of the absorbents of the arm, and the axillary glands afterwards swell; 2d, that by transfusing into the veins most of the substances that are applied in frictions, effects analogous to those which take place in these frictions are produced. Thus purgatives and emetics, transfused or absorbed, act

upon the intestines and stomach the same as if introduced in any other way. It seems to me that sufficient use has not been made of the experiments of the last age upon transfusions. By comparing their effect with that which takes place upon the cutaneous organ, I think that it is impossible not to admit a morbific principle in the blood, at the time of contagious diseases.

3d. After the use of mercury taken in frictions, the emanations of this metal from the animal fluids, act evidently upon silver when placed in the mouth, the rectum, &c. I am persuaded even that the blood which in the natural state exerts but very little action upon this metal, would alter it then. Accoucheurs know that the waters of the amnios of those women who have made use of mercurial frictions exhibit the same phenomenon.

4th. Many substances that are not medicinal can be transmitted to the blood by cutaneous absorption. Water appears to enter it in this way, in the rapid production of certain dropsies, in those cases related of travellers, who wanting fresh water on the ocean, have in part quenched their thirst by surrounding themselves with damp clothes, &c. When our garments are impregnated with the oil of turpentine, the urine soon acquires an odour that is owing to the principles transmitted to the blood by absorption. Many judicious philosophers have asserted that the weight of the body has been increased by a walk in the morning.

I have observed that after remaining in the dissecting room some time, the intestinal flatus frequently acquires an odour exactly similar to that which the bodies in putrefaction exhale. In the following way I convinced myself that it was the skin as much as the lungs that absorbed these odorous particles. I closed my nostrils, and fitted a long tunnel to my mouth, which passing out of the window allowed me to breathe the external air. The flatus from my bowels, after I had remained an hour in a

small dissecting room, at the side of two very fetid bodies, acquired an odour nearly similar to theirs. I have observed also that by touching for a long time fetid substances, the flatus acquires more of this odour, than by remaining only in an air loaded with cadaverous exhalations. Then the absorbents carry at first these exhalations to the blood, which afterwards throws them out by the mucous surface of the intestines. Thus when the urine is absorbed, the saliva, the mucous juices, &c. have an urinous odour.

I could accumulate many other proofs of cutaneous absorption; but I have selected only the principal. Many others have been cited; Haller in particular, to whom I refer, has multiplied examples of it.

I would remark however that cutaneous absorptions have a character of remarkable irregularity; that under the same apparent influence, they sometimes take place and sometimes do not. It is thus that most often we absorb nothing in a bath, that we escape or take contagions, that the vaccine disease is or is not communicated, that the variolous inoculation is also often uncertain, &c. This is not astonishing. It requires a certain degree of sensibility in the skin for the absorption of this or that substance; above or below this degree, the absorbents repel this substance. Thus in the intestinal canal, if you raise by a purgative, the ordinary degree of sensibility of the lacteals, they cease immediately for a time to take up drinks, chyle, &c. and every thing passes off by the anus. Now a thousand causes act incessantly upon the skin; a thousand irritants by turns applied to it make the degree of its organic sensibility vary every instant, increase, diminish and remove it from that which is necessary for absorption.. Is it astonishing then that this function should exhibit so many varieties? Many modern philosophers have produced numerous negative facts against cutaneous absorption. What do these facts prove? only

the varieties of sensibility which I have noticed ; but they do not destroy the mass of positive facts, generally acknowledged and which together form a body of proof which nothing can oppose. Thus we have seen the mucous surfaces variable in their vital forces on account of the variety of their excitants, vary also in their absorption. If in the serous membranes, in the cellular texture, in the work of nutrition for the organs, this function is uniform, it is because being constantly in contact with the same bodies, the surfaces where it is going on have an uniform degree of organic sensibility.

Many facts, in relation especially to contagions seem to prove that a state of weakness is favourable to cutaneous absorption. 1st. Children and women absorb more easily than strong and vigorous men. 2d. Many physicians have observed that in the night in which the cutaneous organ is in a state of remission in this respect, as it is not stimulated by external objects, contagious diseases are more easily taken. 3d. I have remarked that most of the pupils who have fallen sick during my dissections, had carried to their chambers portions of subjects, the emanations from which had been able to affect them during sleep. 4th. We know that practitioners recommend, that persons should not expose themselves to contagious miasmata during hunger, as the forces are then languid on account of the emptiness of the stomach.

Exhalants.

The external capillary system which surrounds the chorion and embraces the papillæ, appears to be the origin of these vessels, as it is the termination of the arteries of the dermoid spaces. The exhalants take up their fluid there, which they throw out upon the epidermis. We have no anatomical knowledge as to their form, their length, their course and their direction ; but their exist-

ence is incontestibly proved, 1st, by injections, which are sometimes poured out upon the whole cutaneous surface; 2d, by the sanguineous exhalation which takes place in some diseases in which there is a real bloody sweat; 3d, by the natural sweat and by transpiration, which can evidently have no other agents, though some authors have admitted that there were certain pretended glands for the secretion of these fluids.

An infinite number of calculations has been made to ascertain the quantity of fluid which the cutaneous exhalants usually pour out. We are dismayed when we read the result of the labours of many philosophers upon this point, when we go over the calculations, enormously multiplied, of Dodard, Sanctorius, Keil, Robinson, Roye, &c. To what do all these calculations, for which the life of a single man would perhaps be insufficient, tend? To prove to us that when we start from a false principle, the whole chain of consequences drawn from it is false, though these consequences may be rigorously deduced from each other. In fact, most philosophers have considered the skin as a kind of fountain with numerous capillary tubes, always throwing out in the same time the same quantity of fluids, and being able consequently to be subjected, like inert capillaries which pour out fluids, to proportions and calculations of quantity. But the results of these calculations have soon proved how mistaken their authors were. Read these results, and you will see that none of them agree, that frequently very great differences characterize them. Is this astonishing? A thousand causes make the transpiration vary at every instant. Temperament, exercise, rest, digestion, sleep, watchfulness, the passions, &c. increase or diminish the action of the cutaneous exhalants. I do not speak of the difference from climate, seasons, &c. which is still more decided.

An attempt has even been made recently to ascertain, what belongs to the urine, to the transpiration, to the pul-

monary perspiration and to the excrements, to calculate the relation which exists between the quantities thrown out in these four ways; useless researches! We might obtain from them results for one man, which would not be applicable to others. Thus see if we have ever been able to make a single useful application to physiology or pathology of all these immense labours on transpiration. What would you say of a man who, during the days of the equinox, in which the state of the atmosphere was every minute changing, should try to establish proportions between the quantities of rain which fell in every quarter of an hour, or of one who endeavoured to fix relations between the quantities of fluids which are evaporated in given times, from the surface of a vessel under which the intensity of the heat which warmed the water varied every instant. The comparison is just. We might be able to say in general, at the end of a given time, nearly how many pounds of substances went from the body; and yet this varies in every individual. But to attempt to say in a general manner what, in this common quantity, the urine and transpiration separately furnish, is to prove that we do not understand the nature of the vital forces.

We have already observed, that all our knowledge upon the varieties of transpiration, is reduced to some general data; that, for example, in cold seasons and climates, it is by the internal emunctories that the residue of nutrition and digestion principally passes off, whilst in warm climates and seasons, it is the cutaneous organ that principally throws it out.

The skin on the one hand, and the kidneys and pulmonary surface on the other, are then in this respect, in a constantly inverse activity. Physicians very well know this difference in regard to the urine and sweat; they know that when one is increased, the other is diminished; that in winter the urine contains principles of various kinds, and that in summer the transpiration has a salt taste

and other peculiar characters which it owes to the substances which are foreign to it in the first season. But they have not so well examined the relation of the transpiration with the sweat ; this determined me to make the following experiments :

I wished to know what is the state of the respiratory fluid in summer, in which there is much transpiration, and in which all the heterogeneous principles consequently go out by the skin. To obtain this fluid which is exhaled in insensible vapour, I placed a clean, empty bottle in a pail filled with ice and the muriate of soda, and I respired a long time in it, taking care not to allow any saliva to fall in. The parietes, chilled by the external ice, condensed into small icicles the vapour of my breath, on the internal surface of the vessel. When I had made a certain quantity of these, I withdrew the bottle ; then by putting it into tepid water, the icicles immediately melted, and I had in a liquid state my respiration, which was before in vapour. Now I have been struck with two things in this experiment, 1st, with the small quantity of fluid that I was able to obtain, though I had respired for an hour, and afterwards made two men respire each an hour ; 2d, with this, that most of the reagents have no action upon this fluid. Nitric, sulphuric and muriatic acids, lapis infernalis, and alkohol produce no effect when mixed with it. In evaporating a small quantity in the concavity of a watch chrystal, no residuum is left ; placed in a spoon over the flame of a candle, it experiences no alteration from the heat. In a word, I have been almost tempted to believe that it was nothing but water. I confess however that this experiment ought to be carefully repeated.

The little fluid obtained made me believe that the form of the vessel was not well adapted to the purpose, because it did not present sufficient surface and the vapour of the lungs was too little divided. I took then the spiral cylin-

der of a small alembic which I surrounded with ice in a pail; I made a man breathe through it, and I obtained in fact more fluid, but infinitely less however than I expected, considering the great cloud that is formed in winter by respiration. In an hour, two ounces of fluid only were condensed, which I weighed comparatively with water, and found a little heavier, a proof that some principles are mixed with its aqueous portion, and with which I am unacquainted.

I am convinced that in winter I should have condensed much more vapour; the inspection of an animal that breathes proves it even, as I have just said. I am persuaded also, that like the urine, the respiratory fluid is then charged with principles which, during summer, pass off by the skin, though I have not however any experimental data upon this essential point, which I propose to clear up the approaching winter. I think even that many colds depend upon this. In fact, many of these principles thrown out by the mucous surface of the bronchia, not soluble in the air, like their aqueous vehicle, stagnate upon this surface, irritate and excite a cough which throws them off. On this account, we cough much in winter, as we have often occasion to bathe in summer, when the saline substances, which are accumulated upon the skin by the exhalation that takes place there, cannot be evaporated by the air. Hence why also in many affections of the lungs, in which the mucous glands and the bronchial exhalants do not increase the quantity of fluid they usually pour out, but only separate with it, on account of their change of organic sensibility, substances which the air cannot dissolve, hence, I say, why in these affections there is a constant cough; for, as I have said, when a substance remains for any time upon the mucous system, it irritates, and it makes an effort to get rid of it. I believe that this elucidates the cause of many coughs, which have been considered as nervous, on account of the small quan-

tity of expectoration, and which are only a means that nature employs to supply the want of the evaporation of the air.

I think that physiologists have not paid sufficient attention, either as it respects the bronchia or the skin, to the part which can be evaporated, and to that which cannot. Some animals seem to throw out more of these principles that cannot be evaporated, than man; hence why it is necessary to curry horses every day, and even to bathe them often, in order to cleanse their skins which the air would leave dirty. Fourcroy and Vauquelin have remarked that there is never phosphate of lime in the urine of these animals; this substance appears to pass out with the sweat, and to be chrystalized on the surface of the skin, from which it is removed by friction and water. I can hardly conceive how the hairs can be the emunctories of it; it appears to me to be more natural to think from analogy, that it is by the sweat that it escapes. I presume that the rain, in the natural state is as necessary to these animals as to plants. The first do not avoid it; many even expose themselves to it; it serves as a bath for them, removes the saline particles the air does not dissolve, and washes the skin.

The cutaneous exhalants do not appear to be everywhere equally abundant. The face and chest contain many of them; we sweat easily in these places. On the back and the extremities they are less numerous. It is rare that we sweat on the palms of the hands and the soles of the feet. Besides this varies remarkably in different individuals. I know two sisters, belonging to a family in which phthisis has been frequent, whose chests are however well formed, and who have never had any sign of an affection of the lungs, and yet when they are warm they always sweat from the chest. We know that in some the sweat appears most usually in the face, and in others on the cranium.

Have the nerves any influence upon the cutaneous exhalation? In many cases of paralysis, the patients sweat from the sound side. I have attended, for two months past, a man at the Hôtel Dieu, who after an apoplexy, had hemiplegia so that the left side of the body was immoveable, and who only sweats from this side, so that an evident line of demarcation is visible the whole length of the median line. On one side the skin is dry, and on the other it is very moist. I know cases are related in which opposite phenomena have taken place; but they do not destroy the observation that is uniformly made, that the sweat takes place equally upon the sound and the diseased side. Besides, who does not know that when the nervous action is annihilated in a limb, a blister acts upon it as usual? Do convulsions, in which the nervous action is so much raised, increase cutaneous exhalation? Have the states of extreme sensibility, in which all the cutaneous nerves are so susceptible of receiving all impressions, the least known influence upon sweating? Let us acknowledge then that in cutaneous exhalation, as in secretion, we know nothing of the nature of the nervous influence, if it does exist.

Sebaceous Glands.

Besides the insensible transpiration and the sweat, which are thrown out by the skin, this organ is constantly lubricated by an oily fluid, which occasions, when coming out of a bath, the water with which it does not unite, to collect in small drops upon the body, which greases the linen when it remains too long in contact with the skin, catches the dust that is floating in the air, makes it remain upon the skin, and retains many foreign substances coming with the sweat from without or within.

This fluid is in general much more abundant in negroes, whose skin is on this account disagreeable, than in European nations in whom it abounds especially in places

provided with hair, particularly on the cranium. If left without dressing, the hair becomes greasy, unctuous and shiny; it seems even that this abundance of oily fluid is destined to support their suppleness. Thus art imitates nature in the preparation of it, and greasy substances almost always enter into the dressings of the toilet. It appears that there is less of this fluid in other parts where there are hairs. It oozes in very small quantity from the soles of the feet and the palms of the hands, no doubt on account of the thickness of the epidermis. When we wash these last, the water collects in small drops on the back of them, and not in the palms, which are easily and uniformly wet; there is never any of it deposited on the surface of the nails. This cutaneous oil, retained in certain places, as in the axilla, the perineum, the folds of the scrotum, &c. becomes mixed there with certain principles of the transpiration, and often exhales a fetor that is almost insupportable.

This oily fluid, of the nature of which we know but little, is not like the transpiration or the fat exposed to evident increase and diminution; it is always found in nearly the same proportion. It appears to preserve the suppleness of the skin, by preventing it from cracking. The ancients sought no doubt to imitate its action over the whole skin, as we imitate by pomatum its functions in regard to the hair, by the oily unctions which they made upon the body. This we know was much practised among the Romans.

Whence comes this cutaneous oil? It can be furnished from three sources, 1st, from transudation; 2d, secretion; 3d, exhalation.

Some have thought that the sub-cutaneous fat oozed through the pores to form it; but the scrotum which is destitute of this fat is one of the most oily parts. The skin of the cranium, which is so to the highest degree, is hardly at all fatty. That of the cheeks which covers

much fat, is scarcely lubricated with it, &c. In emaciation the skin is often as unctuous as in corpulency, though it is not always the case. Finally, in all the other functions, physical transudation is proved to be nothing; would it exist then here alone?

Those who admit the secretion of the cutaneous oil, (and they are the greatest number,) place the source of it in the small glands that are called sebaceous, and which they say are everywhere spread under the skin. We see some small tubercles upon the convexity of the ear, upon the nose, &c.; but in most of the other parts it is impossible to distinguish any thing; we see only the small eminences of which I have spoken and which make the skin rough; now they have nothing in common with these glands, the existence of which I do not deny, but which I confess I have many times in vain sought for.

This has made me think that there is perhaps an order of exhalants destined to separate the cutaneous oil, and which is distinct from that of the exhalants which throw out the transpiratory matter. There is in the cellular texture exhalants for fat and others for serum. Certainly no gland presides there over the secretion of the fat. It is the same with the marrow which the exhalants of the medullary membrane furnish. There is I think as much probability in the supposition of the exhalation, as of that of the secretion of the cutaneous oil.

Besides, we must not confound this oil, either with that ceruminous matter which certain glands pour out on the edges of the eyelids and behind the ears, and which is forced out by pressure in the form of little worms, or with that whitish substance that is collected between the glans and the prepuce, and which is so evidently furnished by small glands.

ARTICLE THIRD.

PROPERTIES OF THE DERMOID SYSTEM.

I. *Properties of Texture.*

These properties are much developed in the skin. The alternations of emaciation and corpulency through which our organs, the limbs especially, pass sometimes from a determinate size to one double or even treble, and afterwards return to their primitive state, prove these properties; and so do all the different tumours, deposits of pus, external aneurisms, sudden engorgements which accompany great contusions, aqueous collections in the abdomen, pregnancy, scirrhi, numerous affections which increase the size of the testicle, hydrocele, &c. We see in all these cases the skin at first extended and dilated, then contracting when the cause of the distension has ceased, and occupying the place in which it was originally circumscribed.

The remarkable separation which the two edges of a wound experience, that is made by a cutting instrument, is owing to the contractility of texture. This separation which takes place upon the dead body, proves what we have already often remarked, viz. that the properties of texture, absolutely inherent in the organic texture, are foreign to the vital forces from which they only borrow an increase of energy; thus the cutaneous retraction is much stronger during life in a longitudinal or transverse wound. But it is particularly in amputation that we observe this increase of contractility from the vital action. No part, not even the muscles retract so much as the skin; hence the precept so much recommended in this operation of saving the integuments as much as possible; hence the

essential modifications that have been made in the ancient methods. The muscular retraction is more sudden ; but this, which is more durable, ultimately prevails ; so that in the ancient mode of amputation, where every part was cut at the same level, they had a conical stump, the summit of which was formed by the bone, in which was next seen the muscles, arteries, &c. and in which the skin representing the base, terminated on the side of the limb.

There are however many cases in which the dermoid extensibility is less than it at first seems to be. For example, in large sarcoceles, the skin of the neighbouring parts of the scrotum being drawn, is applied upon the tumour, and makes up for the extensibility that is wanting in the skin of this part ; that of the penis especially is almost wholly employed to cover the tumour ; so that this organ disappears. It is to the limits placed to the cutaneous extensibility that must also be referred the following phenomenon ; in a wound with loss of substance, the fleshy granulations, in contracting by the evacuation of the white substance that filled them, draw the neighbouring skin in order to cover the wound ; now this drawing produces not only an extension but a real locomotion. Hence why when the skin, naturally tense and adherent, cannot yield to this locomotion, the cicatrices are formed with so much difficulty, as we see upon the cranium, the sternum, &c. ; why on the contrary on the scrotum, the fold of the axilla, &c. they take place with so little ; why in dissecting out tumours, it is so much recommended to save the sound integuments, &c.

When the skin is stretched, the fibres which compose the spaces that have been spoken of, separate from each other, and these spaces become broader. Their breadth becomes especially evident on the internal surface of the dermis ; for as all the pores of the external surface pierce obliquely its texture, the distension of this texture only diminishes the length of the small canal they form, but

does not enlarge the orifice of it; thus whilst the internal surface contains interstices of considerable size, this remains uniform, but allows us to see these interstices, which render it more transparent where they exist; hence that appearance like marble on the skin of the abdomen of women who have had many children.

When the skin is contracted, the internal spaces are drawn together and even effaced. The external surface which has none of these, cannot diminish so much in breadth, so that there is a disproportion in the breadth of the internal and external surface; hence, as I have said, the convexity of the latter in the horny hardening produced by boiling water; hence also the inequalities and external roughness which takes place when cold acts powerfully upon us, and which contracts the dermoid texture. Besides, this phenomenon only takes place when the contractility is evident in the ordinary state; for if there has been previous distention, the cells already enlarged, return only in contracting to their natural state, and there is no disproportion in the extent of the internal and external surfaces of the skin.

In most of the extensions, there is a diminution of the thickness of the dermoid texture. It is only when it is dilated by the infiltration of water in its spaces, as in leucophlegmasia, that it increases in thickness by diminishing in density. In chronic inflammation, in engorgement, and in various alterations of which the dermoid texture is the seat, it loses in part the faculty of stretching; it breaks with ease when it is distended. This is what happens in some aneurisms, in those of the aorta especially that have produced an absorption of the sternum. A slow inflammation seizes upon the skin that covers the tumour, and it breaks with a degree of distention infinitely below what it bears in a sound state, if the death of the patient does not prevent this fatal rupture, two examples of which I have seen in the ward of lying

in women at the Hôtel Dieu. In this state of inflammation, the distention is very painful, whilst it is not so in the ordinary state.

The skin loses also its contractile power in most of the chronic affections of which it is the seat, and which alter its texture.

Are there some days in which the skin is more contracted, and others in which it is looser and more expanded? I believe so, from observing the marks left after small-pox, which are much more apparent and deeper some days than others.

II. *Vital Properties.*

These are strongly marked in this system. We might say, that nature by giving an excess of life to this dermoid covering, has wished to establish a striking line of demarcation, and to make us perceive the difference between the inorganic bodies with which its external surface is in contact, and the organized textures that its internal surface covers. I shall consider these vital properties as in all the other systems; some belong to animal life and others to organic.

Properties of Animal Life.

The animal sensibility exists in the highest degree in the skin. It presides over the feeling, which is more acute and delicate there than in most of the other textures. It is also the cause of touch, a double function which is very different.

The feeling is the faculty of perceiving the impression of the surrounding bodies. It gives us the sensations of heat and cold, moisture and dryness, hardness and softness, &c. It has relation then, 1st, to the existence; 2d, to the general modifications of external bodies. Its exercise precedes that of all the other senses which cannot

be exercised until after its action. It is necessary to the sight, to hearing, smelling and the taste, as it is to the touch. It depends only upon a particular modification of the animal sensibility; it is nothing but this property considered in exercise. Thus when the particular modifications of this sensibility which preside over the other senses have been destroyed, when the eye is insensible to light, the ear to sounds, the tongue to tastes and the pituitary membrane to odours, these different organs still preserve the faculty of feeling, both the presence of bodies and their general attributes.

The touch has only relation to the particular modifications of bodies; it is the source of our notions upon their external forms, their dimensions, size, direction, &c. It differs essentially from the four other senses.

1st. In this, that it does not require, like the feeling, any particular modification of sensibility. The hand is a little more sensible than the rest of the skin; but there is not a great difference, and we should touch bodies almost as well, if that of the abdomen covered the phalanges. On the contrary, each sense has a peculiar sensibility which places it exclusively in relation with a determinate body in nature. The pituitary membrane would be struck by light in vain, if placed at the bottom of the eye like the retina; the palatine membrane if it lined the nasal fossæ, would not perceive odours, &c.

2d. The touch is exercised only upon masses, more or less considerable parcels. The other senses are brought into action by the insensible and infinitely multiplied particles of bodies, as the luminous, savoury particles, &c.

3d. Most of the other senses do not require the previous exercise of the will. Odours, light and sounds strike upon their respective organs, and often produce, without our attending to them, their respective sensations. It is the same with feeling; the will most commonly has no part in it. It is exercised because we live in the midst of

many excitements. We do not most often seek for the causes of general sensations; they are those that come and act upon us. On the contrary, the touch requires to be produced by an act of the will. It is exerted in consequence of the exercise of the other senses; it is because we have seen, heard or felt an object, that we touch it. We confirm or correct by this sense the notions, which the others have given us. Hence why it is, as it were, dependant on them. The more they are contracted, the less frequently is it exercised. The blind, the deaf, &c. have less desire to touch than him, who has all his sensitive gates open to the impression of external bodies.

4th. Most of the other senses require a peculiar structure as well as a peculiar sensibility in the organs which compose them. On the contrary, the touch only requires a particular form in its organs. Provided that these have on the one hand animal sensibility, and on the other can embrace by many points external objects, they can distinguish their tangible qualities. The touch will be obscure if we grasp bodies in one or two directions only; yet it will take place. Thus we touch with the hollow of the axilla, the bend of the arms, hams, &c. with the lips and with the tongue. Thus the elephant touches with his trunk, reptiles by twining themselves around bodies, most animals with their snouts, &c. But the more the points of contact are multiplied, the more perfectly is the sense exercised. The hand of man is in this respect the most advantageously formed; it proves that he is better adapted to communicate with what surrounds him than all other animals; that the empire of his animal life is naturally much more extended than that of theirs; that his sensations are more accurate, because they have a means of perfection that theirs have not; and that his intellectual faculties are destined to have an infinitely greater sphere, since they have an organ infinitely better than theirs to perfect them.

The sensibility of the skin resides essentially, as we have seen, in the papillary body; it is there that all the great phenomena relative to sensation take place. It is this portion of the skin that truly belongs to animal life, as the reticular body is, on account of the vascular plexus that forms it, the portion essentially dependant on organic life. The chorion being as it were passive, remains foreign to every kind of important function, and serves only for a covering.

The extremely acute sensibility of the papillary body requires a covering to defend it from strong impressions. This covering is the epidermis. When it is removed, every touch is painful; the impression of the air even is very much so; it is this removal of the epidermis that produces the smarting that is felt when a blister is taken off. Observe in fact that smarting is a very frequent kind of pain, which the animal sensibility of the skin occasions when more raised than usual. This term * is borrowed from burns, which, when they are only to a certain extent, acting nearly like blisters, lay the papillæ bare; now as it is always the skin which is exposed to the action of fire, we transfer to all burnt organs the ideas which we attach to the word smarting. But the pain is far from having the same character in the other systems; this peculiar one belongs only to the dermoid, in which it takes place from a burn, erysipelas, after a blister, &c. and during all inflammations that have their seat in the reticular body. No other system when inflamed gives us this sensation. The pain is throbbing in the cellular; it exhibits a wholly different modification in the muscular, when it is the seat of acute rheumatism, &c.

There is another kind of pain which is also peculiar to the cutaneous system; it is itching, which is the first

* In order to understand this sentence it should be observed that the word which I have translated smarting is *cuisson*, which means the action of fire upon animal bodies, and is also used for the painful sensation which this action produces.—Tr.

degree of smarting. We remove it by a gentle friction, which exciting in the papillæ a different sensation, effaces that of which they are then the seat; but when this new sensation has passed off, the former one, which is occasioned by a permanent cause, is reproduced and requires a new friction; there happens then in a small way, what we observe in a large one, when a stronger pain makes us forget one that is weaker. No other system in the economy exhibits this kind of pain, so frequent in itch, herpes and many other cutaneous eruptions. In their tubercular inflammations, the serous membranes become the seat of white eruptions, analogous to many of those of the skin; the mucous surfaces are also often affected with many small pimples; now this sensation is never manifested in either of them.

There is also a sensation which appears to be the minimum of that pain of which smarting is the maximum; it is tickling, a mixed sensation, an hermaphrodite, as an author has called it, which is agreeable when carried to a certain degree and painful beyond it. Carry the fingers lightly over a mucous or serous surface, a muscle or a nerve laid bare; an analogous sensation will never arise from the contact.

The animal sensibility of the skin is, like that of the mucous surfaces, subjected to the essential influence of habit, which can transform successively into indifference or even into pleasure, what was at first painful. Every thing that surrounds us furnishes constant proof of this assertion. The air in the succession of the seasons, caloric in the numerous varieties of the atmosphere, in the sudden change from one temperature to another, water in a bath, in the moist vapours with which the medium is loaded in which we live, our garments of which some, as those of wool, are at first very painful, every thing which acts upon the skin by mere contact, produces sensations in it which habit continually modifies. Observe the mode

of dress of different nations; in some, all the superior extremities are bare; in others, the fore-arm only appears; the inferior extremities, either in whole or part, are naked in others; in some, a more or less considerable portion of the trunk is left exposed to the air, and among the savages, nothing is covered. The portions which in each people remain naked, bear the contact of the air, without giving any painful sensation. Let them expose, on the contrary, parts usually covered, especially if it is cold, and at first pain will be the consequence of it; then the parts gradually becoming accustomed to this contact, will get to be insensible to it. There has been much said latterly of the danger of the Grecian costumes, of the nudity of females, &c. I do not speak of the morality of them; but every thing that is reprehensible physiologically is, that the progress of the fashion has been more rapid than that of the sensibility. If they had exposed at first the neck, then a little of the chest, then the bosom, &c. habit would by degrees have given a new modification to this property, and no accident would have resulted from it. But in going suddenly from a costume in which every part is covered, to that in which the superior half of the chest, either before or behind, remains naked, is it astonishing that colds, catarrhs, &c. should be the result of it?

Habit extends its empire, in relation to the skin, even to our manners themselves. Decency is in this respect a thing of comparison. An Indian woman, with nothing but a narrow cloth around the pelvis, would be with us an object at which the public modesty would be shocked. The habit of mankind serves her as a veil in her own country. A female savage transported entirely naked to the same country, would be indecent there; she is not so in her own. Observe our fashions in their rapid succession; a woman, who by not changing her costume, would have had two years since, that of a courtezan, would now

find herself dressed with great modesty. Indecency in costume is that merely which shocks our habit. The female Indian, with the rag that covers only a quarter of her body, is more decent than the woman in whom a small opening separated the neck-handkerchief in our old fashions. The sight of the face shocks those people among whom females are veiled. Let us consider then habit as the type of the decency of costumes. Nature has wished in physiology, that the phenomena over which it presides, should be slowly connected; it is the same in morals. The woman who suddenly changes her dress from one that is close to one that is not, exposes herself to painful sensations, to catarrhal diseases, &c. and shocks the eyes of those who had been accustomed to see her in a different exterior. When the change is gradually and insensibly brought about, neither health nor morals are affected.

Habit does not modify the cutaneous sensibility which arises from an alteration of texture, from an inflammation, &c. Powerfully raised in this last state, it is much above its natural level. Then the least contact becomes extremely painful; thus the skin is no longer then in a state to exercise the sense of feeling. The touch itself does not distinguish general sensations.' All bodies make a common and uniform impression, it is that of pain.

The animal sensibility of the skin sometimes diminishes and even disappears; paralysis is a proof of this. These affections, more rare than the loss of motion, often however take place. In the organs of the senses, it is the eye which most frequently loses the sensation; the ear comes next, then the skin, then the nostrils and finally the tongue, which is the sensitive organ that is always most rarely paralyzed, no doubt because it is that which is the most connected with the support of organic life, without which we could not exist. The others belong especially to animal life, which we can lose in part without ceasing to exist.

The whole skin is never at the same time paralyzed; there is rarely even hemiplegia in this respect; the feeling is not extinguished but in an insulated part. I would remark that the existence of these paralyses is also a proof of the want of nervous influence upon cutaneous exhalation and the capillary circulation, since both go on very well in this case as well as in paralysis of motion, as I have observed above. Cut the nerves of a limb of an animal, in order to render this limb insensible; if after this you apply an irritant, the skin will inflame as usual.

When the animal sensibility is in exercise, is there a kind of erection of the papillæ that they may feel more acutely? The same observation may here be made as was in regard to the mucous surfaces. This erection is an ingenious idea of some physicians, and not a fact which rests upon observation. I even think that this contradicts it; for examined with a glass the papillæ appear to be constantly in the same state. Why should not the skin feel like a nerve laid bare, like the eye, the ear, &c. in which these sorts of erections have never been imagined?

Animal contractility is wholly foreign to the cutaneous organ, which moves voluntarily only by the influence of its fleshy pannicle.

Properties of Organic Life.

Organic sensibility and insensible contractility exist in the highest degree in the cutaneous organ. The external capillary system, which forms the reticular body, is, as I have said, especially the seat of these properties. They are in constant activity in order to preside, 1st, over the capillary circulation; 2d, over exhalation; 3d, over absorption; 4th, over the nutrition of the whole dermoid texture; 5th, over the secretion of the cutaneous oil, if the sebaceous glands exist. It is not astonishing that

these properties should be so much developed in the skin, in which they have so many functions to support. Add to these considerations the constant action of external bodies, an action which keeps this organ in continual excitement, which incessantly stimulates its sensibility, which is to this sensibility what that of the bodies contained in the mucous surfaces is to the sensibility of these surfaces; the irritation is even more sensible, because the stimuli are oftener changed. A thousand agents of nature, of different density and composition continually succeed each other on the exterior of the body, and at the same time that they act upon the animal sensibility of the skin, to produce various sensations, they excite the organic sensibility in order to support the functions over which this sensibility presides.

Is it astonishing then that the greater number of cutaneous diseases supposes an alteration in this property and in the insensible organic contractility which is not separated from it? I divide these diseases into four classes, according to the structure we have distinguished in the skin.

1st. There are diseases of the papillæ; these are the paralyses and various kinds of increase of feeling, which reside only in the nerves. Women are especially subject to these last, which are so great in some nervous affections, that mere contact of the skin if considerably powerful produces convulsions. To this also should be referred the extreme susceptibility of some individuals in whom tickling produces a general revolution. It is necessary to distinguish these exaltations of animal sensibility, from those of which we have spoken above, and which depend upon inflammation. The organic sensibility is especially affected in these last; we might say that by its increase it is transformed into animal sensibility; whereas in the other case this last property alone is altered.

2d. There are diseases which have evidently their seat in the cellular texture which occupies the dermoid spaces; such are the inflammations of the cutaneous portion which covers a phlegmon, a bile, &c.

3d. There are diseases of the external capillary net-work, from which the exhalants arise. To this must be referred erysipelas, many species of herpes, measles, scarlatina and many acute cutaneous eruptions that are daily met with in practice.

4th. Finally, there are diseases in which the chorion is affected. Elephantiasis, and in general many chronic cutaneous diseases appear to me to be of this number, and I will even observe that the chorion never appears to be primarily affected in acute diseases. The obscurity of its vital forces, its dense and compact texture, and its comparative want of vessels prevent it from accommodating itself except to chronic affections. In phlegmonous erysipelas, in biles, &c. it is only influenced, but it is not essentially diseased. Thus we have seen that all the affections of the osseous, cartilaginous, fibrous, fibro-cartilaginous systems, &c. are really slow and chronic, on account of the texture and the vital obscurity of these systems.

Now if we reflect on this division of cutaneous diseases, we shall see that except those of the first class, which are not numerous and which consist in greater or less alterations of animal sensibility, we shall see, I say, that all the others suppose a more or less considerable affection of the organic sensibility and of the corresponding insensible contractility. All are derived from an increase, a diminution or an alteration of these properties.

It is also to the different changes of these properties, that must be referred the more or less copious sweats and the various exudations of which the skin is the seat. In fact, the exhalant vessels remain always the same in relation to their structure. Why then do they admit a greater

or less quantity of fluids? Why at certain times do they allow of the passage of substances, which they repel at others? It is because the modifications of their organic forces are changed. These forces are often weakened in an evident manner in diseases; they become languid and are prostrated. Then blisters are applied in vain; the organic sensibility no longer answers to the excitement that is made upon it. This is a striking phenomenon in ataxic fevers, and proves the independence of the phenomena of cutaneous exhalation, capillary circulation, &c. in regard to the cerebral nerves. In fact, whilst during the paroxysm the brain is in extreme excitement, the voluntary muscles are put by this excitement into a violent state of convulsion, and the energy of the whole of the animal life seems to be doubled before it ceases to exist, the organic is already in part exhausted; the functions of the portion of the skin which belongs to this life have already ceased.

The stimuli of cutaneous organic sensibility vary remarkably in their degree of intensity. 1st. The strongest are fire, cantharides, the alkalies, the acids sufficiently diluted by water not to act but upon the vital forces and not to alter the dermoid texture by the horny hardening, the juices of many acrid and corrosive plants, certain fluids even produced in the economy, as those of cancers, &c. All these stimuli redden the skin when they are applied to it. 2d. Most of the same stimuli, diminished in intensity, stimulate it but slightly. 3d. Finally, aqueous fluids, cataplasms and emollient fomentations seem to produce this excitement the least; they even rather weaken the cutaneous organic sensibility; they seem to act upon it like sedatives and moderate the kind of excitement it produces in inflammations. The same is true of most of the fatty substances; thus oils, butter, grease, &c. are in general not calculated to keep up the suppuration of blisters. It is requisite, in order to keep the skin at

the degree of organic sensibility, necessary for the purulent exudation that then takes place, to mix cantharides with fatty substances.

The skin does not appear to enjoy sensible organic contractility. Stimuli usually produce no other action upon it, than the contraction imperceptible to the eye, which composes insensible contractility, and which takes place especially in the small capillary vessels. There is however one circumstance in which this contraction is, to a certain extent, apparent; it is when cold acts briskly upon the skin, which it wrinkles into goose flesh, as it is called. I have pointed out above the mechanism of this contraction, of which the chorion is the seat, and which holds a medium, like many motions which I have already had occasion to notice, between the two species of organic contractility.

Sympathies.

We shall still follow the division of the sympathies into active and passive, a division which is more remarkable here than in most of the other systems, because the sympathies are much more numerous.

Passive Sympathies.

The animal sensibility is very often brought into action in the skin, by the affections of the other systems. We know that the application of cold to the sole of the foot frequently produces affections of the head; that in many cases, the different species of itching, and even of smarting appear without an injury of the part where the pain is felt. It is useless to cite examples that are known to all physicians. I will confine myself to the sympathies of heat and cold alone, which have not yet been spoken of.

I call by this name the sensation that is experienced upon the skin, when there is not a superabundance or absence of caloric there. There is evidently a material

cause for the heat in inflammation and for the cold in the ligature of a great artery. On the contrary, in the cases of which I spoke, it is but an aberration of the internal sensitive principle, which resembles that which takes place when we refer the pain to the extremity of an amputated limb. This is what occurs in many cases of shivering, in which the internal sensitive principle refers to the skin a sensation of which the cause does not exist. By approaching the fire then we do not become warm, because we really were not cold ; but we only destroy by a real sensation, the opposite sensation which is illusory that we experience, or rather we turn the perception from this sensation. We know that at the instant of the ejaculation of semen, a sudden and sympathetic chill often extends over the body. We know the cold of fear, which almost always arises, like the sweat produced by this passion, from the sympathetic action exerted upon the cutaneous organ by an epigastric organ affected by the passion.

Observe what takes place in the beginning of most acute local diseases, as in those of the serous and mucous surfaces, of the lungs, of the gastric viscera, &c. &c. The organ which is to be the seat of the disease is at first affected ; immediately many sympathetic and irregular symptoms arise in all those which are sound ; this is the affection that precedes. When the disease is once developed, and it follows its periods, a new order is established, as it were, in the economy. The relations of the organs seem to change. In the preternatural irregularity of the functions, a kind of regular assemblage of symptoms is manifested, it is this assemblage which characterizes the disease and distinguishes it from every other in which a different order of morbific relations is established between the functions ; now the passage from the natural to the preternatural relation of functions is marked by a thousand vague symptoms, which should be attributed to

sympathies, and among which appears particularly the kind of shiverin of which I have spoken.

In the beginning of digestion a kind of sympathetic cold is also referred to the skin, which is most often as warm as usual; it is an action exerted by the stomach upon the cutaneous sensibility, an action from which arises a particular sensation, different no doubt from that which the same viscus, when disordered, produces in the head, occasioning head-ache, but which is owing however to the same principle.

The heat is very often sympathetic in the cutaneous organ, less however, as I have observed, than in the mucous system. We know the flushes of heat that so often extend over the skin in an irregular manner, in different fevers, and which are not attended with a greater disengagement of caloric.

Our modern philosophers will not perhaps be able to understand, how it is that whilst in the greatest number of cases, the application of a degree of caloric superior or inferior to that of our temperature, is necessary to produce heat or cold, this sensation can arise in a part though it may not have experienced an increase or diminution of this principle. But in the greatest number of cases has not pain a material cause? And yet all sympathies produce it without this cause. The vulgar, who stop at the diversity of the modifications of feeling, believe that an insulated principle presides over each. Let us disregard all these modifications, in order to see but a single principle in the irregularities as in the regular course of sensibility. That this property, sympathetically altered, gives us the sensation of heat or cold as in the skin, of pulling as in the nerves, of lassitude as in the muscles in the beginning of a disease, &c.; these are but varieties of a single cause, one, of which we are ignorant, but which evidently exists. In general, the sympathies of animal sensibility put into action in each system the sen-

sation which is usual there. The sympathy which, acting upon the skin, creates there a sensation of heat or of cold, would have produced that of lassitude if it had acted upon a muscle.

In order to form an exact idea of heat and cold considered as sensations, let us recollect that they may arise from different causes. 1st. From the increase or diminution of the caloric of the atmosphere. 2d. From the disengagement or the want of disengagement of this fluid in a part of the economy, as in a phlegmon or after the ligature of an artery of a limb. 3d. Sometimes without previous inflammation more caloric is disengaged in the whole body ; there is a general increase of temperature ; we then feel an internal and external heat ; or caloric is disengaged locally in a part of the skin, and the patient feels a heat there as he does who applies his hand upon this place. 4th. Finally, there are sympathies of heat and cold. Some other parts, besides the mucous surfaces and the skin, feel these sympathies ; we know the sensation of coldness that is felt to arise from the abdomen to the thorax, &c.

The organic properties of the skin are also frequently put into action by sympathies. The sweat on the skin is suppressed in a moment, if a cold body is taken into the stomach. The entrance of teas into this viscus, and an increased cutaneous exhalation, are two phenomena that take place almost at the same instant ; so that we cannot refer the second to the absorption of the drink, then to its passage into the black blood through the lungs, and afterwards into the red blood. The production of sweat is then here analogous to its suppression in the preceding case ; it resembles that of fear, and that of phthisis in which the lungs being affected act upon the skin. Shall I speak of the innumerable varieties of this organ in diseases, of its dryness, its moisture, its copious sweats, &c. phenomena for the most part sympathetic, and which

arise from the relations which connect this sound organ with the diseased parts? I have pointed out those which exist between it and the mucous surfaces. The membrane of the stomach is the one with which it especially sympathizes. The digestive phenomena are a proof of this. It would be necessary to treat of all diseases in order to speak of the sympathetic influences exerted upon the skin. These influences are often chronic. How in many organic diseases, do different tumours form upon the skin? Precisely as petechiæ, miliary eruptions, &c. are produced in acute fevers; the difference is only in the duration of the sympathetic phenomena.

Animal and sensible organic contractility cannot be evidently put into action in the passive sympathies of the skin, since it is not endowed with these properties.

Active Sympathies.

The four classes of cutaneous affections of which we have spoken, occasion many sympathetic phenomena, the following are some of them.

1st. Whenever the papillæ are strongly excited, as in the tickling of very sensitive people, various organs feel it sympathetically; sometimes it is the heart; hence the syncopes that then take place; sometimes it is the stomach; thus I knew two persons who could be made to vomit by tickling them; sometimes it is the brain, as when in very irritable people, tickling is carried so far as to produce convulsions, which is not very rare in nervous women. Who is ignorant of the influence which the organs of generation receive from the skin, when stimulated in different parts?

Physicians are often astonished at the extraordinary effects which some mountebanks produce in the economy, who know how to profit by their knowledge of the cutaneous sympathies produced by tickling. But why should we be more astonished at these phenomena, than at the

vomitings produced by an affection of the womb, at the diseases of the liver arising from an injury of the brain, or at hemicrania the seat of which is in the gastric viscera? The only difference is that we can in the first instance, produce to a certain extent those sympathetic phenomena, which we only observe in the other. Why do we not oftener make use in medicine of the influence which the skin when tickled exerts upon the other organs? In hemiplegia, in adynamic, ataxic fevers, &c. who knows if the excitement of the sole of the foot, which is so sensible, as every one knows, if that of the hypochondrium, which is not less so in some people, &c. would not be better, if repeated ten or twenty times a day, than the application of a blister, the irritation of which soon passes off? Besides you would never obtain by a blister, rubefacients, &c. means which act as much and more upon the organic than the animal sensibility, an effect as striking, an affection as general in the sensitive system, as by the tickling of certain parts, a means, which acting only upon this last species of sensibility, produces phenomena exclusively nervous; whilst the exhalant system and the capillary with red blood are especially affected by the others. Certainly there are cases in which one of these means is preferable to the other. I propose to ascertain these cases.

We have not yet sufficiently analyzed the different kinds of excitement in diseases; we have not endeavoured to profit enough by what observation has taught us, upon the sympathies we can produce at will. Might we not however say, that nature has established certain relations between very remote organs, that we may be able to make use of these relations in our means of cure? The charlatan, who employs external tickling for certain nervous affections, is often more rational, without knowing it, than the physician with all his pharmaceutical means.

2d. Whenever the cutaneous exhalants or the external capillary system from which they arise, are affected in any manner, many other parts feel it, and this is a second order of the active sympathies of the skin. Here are referred a great number of phenomena, of which the following are a part.

A bath which acts upon the skin during digestion, affects sympathetically the stomach, and disturbs this function. When this viscus is agitated by spasmodic motions, oftentimes the influence which it receives from it suddenly calms it, and brings it to its ordinary state. Not long since in my evening visit at the Hôtel Dieu, I saw a woman who was vomiting continually from a sudden suppression of her catamenia. I directed sedatives which were useless. The next evening she was in the same state; I had her put into a bath; every thing was calmed the moment she came out of it, and yet the catamenia did not return. Few organs are more dependant on the skin than the stomach.

The action of cold upon the cutaneous organ produces many sympathetic effects, especially when this action takes place while we are sweating. The term repercussion of transpiration is not proper to express what then takes place; it gives a very inaccurate idea. Let us suppose that a pleurisy arises from cold suddenly applied, the following is what happens; the organic sensibility of the skin being immediately altered, that of the pleura is sympathetically altered. By it the exhalants become in relation with the blood; they admit it instead of the serum which they before received, and inflammation supervenes. Thus this phenomenon is the same as that in which the application of a cold body upon the skin suddenly arrests uterine, nasal hemorrhage, &c. &c.; the result only differs. Now in this last case, no one ever supposed that there was a repercussion of fluid. The suppression of the transpiration is a thing purely accessory

and foreign to the internal inflammation which takes place. When the skin sweats in summer, the vital forces are more raised by the caloric which penetrates it; in this state, it is more capable of acting sympathetically upon the forces of the other systems. Hence why all strong stimulants that act upon it are more to be feared then. It is so true that it is not the suppression of the sweat which is dangerous, but the alteration of the vital forces of the skin which sweats, that many kinds, as the sweat of phthisis, are not so injurious when they cease for a time; they are checked even with much more difficulty, because they are not produced by a cause acting immediately upon the skin. Now if there was a repercussion of the transpiration, every species of sweat that was suppressed would be injurious. We never hear of a peripneumony arising from a suppression of sweat produced by fear, rheumatism, &c. There would be then also a repercussion of mucous matter, when a pleurisy arises from swallowing a glass of cold water. Men judge only by that which is striking. The suppression of the sweat is an effect like inflammation of the pleura, but it is not the cause of it. If there was no sweat the instant the cold was applied to the skin, inflammmation would nevertheless come on. In wounds of the head, with abscesses of the liver, &c. there is no repercussion of fluids.

The trembling of which the voluntary muscles become the seat, the debility of the pulse which the weakness of the action of the heart produces, &c. are phenomena which the influence of the skin affected by cold alone causes. In fact, only this organ, the commencement of the mucous surfaces and all of that of the bronchia, are made cold by the external air; all the others remain at their usual temperature.

We know the innumerable phenomena which arise from the disappearance of herpes, the itch, &c. imprudently produced; in all these cases it does not appear that the

morbific matter is carried to the other organs, though I do not pretend that this never happens. It is the vital forces of these which are raised and which then occasion different accidents; now as these forces vary in each system, these accidents will be essentially different; thus the same morbific cause disappearing from the skin, will produce vomiting if thrown upon the stomach, in which the sensible organic contractility predominates; pains, if it goes to the nerves which are especially characterized by animal sensibility; derangements of sight, hearing and smell, if it affects the respective viscera of these senses; hemorrhage, catarrhs, phthisis, tubercular inflammation, &c. if it attacks the mucous surfaces, the lungs, the serous membranes, &c. in which the organic sensibility is much raised. Now, if the same morbific matter carried upon these different organs, produced these accidents, they ought to be uniform. Do not their varieties, and especially the constant analogy which they have with the predominant vital forces of the organs in which they appear, prove, that they depend upon the cause which I have pointed out?

We know that the serous surfaces and the cellular texture on the one part, and the skin on the other, are often in opposition in diseases. There is no sweat when dropsies are formed; the dryness of the skin is often even more remarkable than the small quantity of urine, &c.

3d. When the cellular texture contained in the dermoid spaces is inflamed, as in phlegmonous inflammation, in biles, in some malignant pustules, &c. there comes on many sympathies which can be referred to those of the general cellular system, which have been already noticed.

4th. The affections of the chorion itself, all marked with a chronic character, on account of the kind of vitality and structure of this portion of the skin, occasion also sympathies which have the same chronic character, but of which we know but little.

The organic contractility cannot be put sympathetically in action in the skin, as it does not exist there.

Characters of the Vital Properties. First Character. The Cutaneous Life varies in each organ.

Though we have spoken in general of the vital properties of the skin, they are far from being uniform or at the same degree in all the regions.

1st. There is no doubt that the animal sensibility of the soles of the feet and the palms of the hands is greater than that of the other parts. Many persons are so sensible in the hypochondriac region, that the least tickling there produces convulsions. The anterior and lateral part of the trunk is always more sensible than the region of the back.

2d. The organic properties do not vary less. The extreme susceptibility of the face to receive the blood, is a proof of it, as I have said. It is generally known that some parts are more proper than others for the application of blisters. Observe on this subject that the places where the animal sensibility predominates, are not the same as those in which the organic is in the greatest proportion. The soles of the feet and the palms of the hands hold the first rank in relation to one, and the face in relation to the other.

In diseases we also see these varieties. Who does not know that some particular parts of the skin are especially the seat of some particular cutaneous affections, and that when these affections are general, they always predominate in certain places. We ought not to be astonished at these varieties, since we have seen that the dermoid texture is infinitely variable as it respects its papillæ, its reticular body, its chorion, &c.

Second Character. Intermission in one relation; continuity in another.

The life of the cutaneous system is essentially intermittent in relation to animal sensibility. All the senses exhibit this phenomenon. Thus when the eye has for a long time gazed upon objects, the ear heard sounds, the nose received odours, and the mouth tastes, these different organs become unfit to receive new sensations; they become fatigued, and require rest to regain their forces. It is the same with regard to feeling and the touch; wearied by the impression of surrounding bodies, the skin requires an intermission of action to regain excitability adapted to new impressions. We know that a short time before sleep, external bodies produce but an obscure sensation upon it, and that their contact has no effect in this state, in which animals seem to lose half of their existence. The more powerfully the cutaneous sensibility has been excited, the more profound is sleep; hence why all painful exercises, great frictions, &c. are always followed by a deep sleep. Yet this sense can sometimes exert itself, while the others sleep; pinch the leg of a man asleep; he draws it away without waking, and has afterwards no remembrance of the sensation. Thus somnambulists often hear sounds, even eat, &c.; for, as I have said elsewhere, sleep may affect but a very limited part of animal life, as it may the whole.

Under the relation of organic sensibility, the life of the cutaneous system is essentially continuous. Thus the functions over which this property presides have a character opposite to the preceding. The insensible transpiration takes place continually, though there may be some periods in which it is more active than in others. The oily fluid is incessantly carried away and renewed; we might even say sometimes that it is when the animal

sensibility is interrupted, that the organic is in the greatest exercise.

It is especially in diseases that they have made this observation, which is besides generally applicable to organic life. All this life is as active and even more so during the night than during the day. Most of the diseases that attack the functions which belong to it, are marked by an increase of activity during the night. All fevers which particularly affect the circulation have their exacerbation towards night. In diseases of the heart, the patients are more oppressed at this period, &c. In phthisis which affects respiration, it is in the night especially that there is hectic fever, sweats, &c. Pneumonia and pleurisy, exhibit frequent exacerbations towards night. In glandular diseases, either acute or chronic we make the same observation. It would be necessary to refer to almost all the affections which alter especially an organic function, in order to omit nothing upon this point. On the contrary, observe hemiplegia, epilepsy, convulsions, various paralysies of the different organs of sense, most mental alienations, apoplexy and other affections which exert their influence more particularly upon animal life, they have not, so often at least, their exacerbations towards evening and during the night, no doubt because in the natural state, this life is in the habit of becoming drowsy and not of being raised like the other which seems to imprint this character upon its alterations. Other causes no doubt have an influence upon this phenomenon; but I believe this to be a real one.

Third Character. Influence of the Sexes.

The sex has an influence upon the cutaneous life. In general the animal portion of this life is more raised in women, in whom every thing that belongs to the sensations is proportionally more marked than in man, who predominates by the power of his locomotive muscles. The

effects of tickling are infinitely more powerful in females. All the arts which require nicety and delicacy of touch are advantageously cultivated by women. The peculiar texture of the chorion, a texture generally more delicate, has no doubt an influence upon this phenomenon. As to the organic portion of the cutaneous life, the difference is not very great. Man appears to be superior in this respect; he generally sweats more; his skin is more unctuous, which proves a greater secretion.

Fourth Character. Influence of Temperament.

The temperament peculiar to each individual is not a less real cause of differences in the skin. We know that the colour, roughness and pliability of this organ vary according as individuals are sanguineous, phlegmatic, &c. that these external attributes are even a character of the temperaments. Varieties of structure no doubt coincide with these. Is it then astonishing that the animal sensibility differs so much, that the touch itself should be delicate in some and dull in others, that some should be very ticklish, whilst others are not so at all, &c.? Ought we to be astonished if the organic sensibility, which is very variable, should determine, according to the individuals, many varieties in the phenomena over which it presides; if in some, it allows much blood to go to the face, and if it repels this fluid in others who are always pale; if some men sweat much, whilst others have the skin almost always dry; if the cutaneous oil varies in quantity; if there are some skins much disposed to eruptions, either acute or chronic, to pimples of different natures, and if others are almost always free from them, even when the individuals expose themselves to the contagion of these diseases; if superficial wounds, of the same extent and made by the same instrument, are sometimes quicker and sometimes slower in healing; if the cure of cutaneous diseases is also very variable in its periods, &c. &c.?

ARTICLE FOURTH.

DEVELOPMENT OF THE DERMOID SYSTEM.

I. *State of this System in the Fœtus.*

In the first periods after conception, the skin is but a kind of glutinous covering, which seems to be gradually condensed, forms a transparent envelope, through which we see in part the subjacent organs, the vessels especially, and which is torn by the least jar. This state continues for a month and a half or two months. The consistence constantly increasing, soon gives to the skin an appearance more nearly like that which it has in infants after birth. Its delicacy is extreme at this period. It has not one quarter the thickness of that of the adult. The moment in which it begins to lose its mucous state appears to be that in which the fibres of the chorion are formed. Until then the cellular texture and the vessels especially composed it, and as the first is abundantly filled with juices during the early periods, it is not astonishing that it should then give way under the least pressure. But when the fibres are formed, the cellular texture diminishes on the one hand, and is concentrated in the spaces that are developed, and on the other the dermoid fibres, more dense than its layers, increase the resistance.

We do not see upon the external surface of the skin of the fœtus most of the wrinkles of which we have spoken above. Those of the face in particular are not seen; the kind of immobility, in which the facial muscles are, is evidently the reason of it. The forehead, the eyelids,

the edges of the lips, &c. are smooth. Besides, the abundance of fat which then distends the integuments of the cheeks, prevents every species of fold there. As the hands and the feet are found in part bent at their articulations, by the attitude of the fœtus, different wrinkles are already formed about these articulations, principally on the hand, where however they appear less in proportion than afterwards. The curved, papillary lines are not very evident on the foot and the hand, even when the epidermis is removed.

The internal surface of the skin is remarkable for the slight adhesion of the subjacent cellular texture, the cells of which filled with fatty particles are removed with great ease, by scraping this surface with the edge of a knife. We see then there the spaces already well formed, and as distinct in proportion as afterwards. By pursuing their dissection from within outwards, we insensibly lose sight of them towards the external surface where the skin is condensed.

More blood enters the skin of the fœtus, than at any other period of life. It is easy to observe this in small animals taken alive from the womb of their mother; for in the fœtuses that are dead at birth, or born prematurely, the cause which destroys life, increasing or diminishing in the last moments the quantity of cutaneous blood, prevents us from drawing any conclusion as to the ordinary state by an inspection of them. The nerves are, as in all the other parts, more evident; but the papillæ, though sensible, as I have said, have not a proportionable increase.

The animal sensibility is not in exercise in the skin of the fœtus, or at least it is very obscure there. This is owing to the absence of the causes of excitement. These are the surrounding heat, the waters of the amnios and the parietes of the womb, which can furnish materials for sensations; but as these causes are always uniform, and have no varieties, the fœtus can have but a very feeble

perception, because acuteness of sensation requires change of stimuli. We know that heat long continued at the same degree becomes insensible, that a long continuance in a bath takes away almost entirely the sensation of the water, because habit is every thing as it respects sensation ; nothing but what is new affects us powerfully.

Is the organic sensibility of the skin in activity in the fœtus ? does it preside over the alternate exhalation and absorption of the waters of the amnios ? This is not the common opinion, it is not even a probable one ; but this question is far from being settled in so precise a manner as many other points of physiology.

Besides, it cannot be doubted that there is a copious secretion of an unctuous and viscid fluid, which covers the whole body of the fœtus, but which is more abundant in some places than others, as behind the ears, in the groin, the axilla, &c. either because it is secreted there in greater quantity, or accumulated on account of the arrangement of the parts. Accoucheurs have it wiped off after birth, and the females of animals remove it by the repeated application of their tongues to the surface of the body. This fluid appears to be to the skin of the fœtus what the oily fluid is to that of the adult ; it defends this organ from the impression of the waters of the amnios. If the sebaceous glands exist, it would appear that they furnish it, for it is certainly from a different source from the sweat. When care has not been taken to remove this covering, it irritates the skin, and may produce excoriations, and a species of erysipelas. The air cannot remove it by solution. Nothing similar oozes from the skin of the infant after birth. Is it because the black blood alone is capable of furnishing the materials of this substance ?

II. *State of the Dermoid System during growth.*

At the moment of birth the dermis experiences a sudden revolution. Hitherto entered only by black blood,

it is at the time the fœtus is born, more or less coloured by it. Some fœtuses come wholly livid, others are paler; there is a remarkable variety in this respect. But all, shortly after they have respired, become more or less decidedly red. It is owing to the arterial blood which is formed and succeeds the venous blood that circulated in the cutaneous arteries. In this respect the state of the skin is in general an index of what goes on in the lungs. If an infant remains a long time of a violet colour, he either does not breathe or breathes with difficulty. The extremities of the hands and the feet in general become red the last. They are those in which the lividity consequently continues the longest, when this lividity is very evident. The blood which goes to the cutaneous organ, enters it in general in a very uniform manner; the cheeks do not appear to receive more of it in proportion. The sudden excitement it brings to the organ, raises its vital forces and renders it more fit to receive the impressions, which are new to it, of the surrounding bodies.

Observe in fact that a thousand different agents, the surrounding temperature, the air, dress, the fluid in which the fœtus is washed, the tongues of those quadrupeds who lick their young, carry to the skin an excitement which is so much the more felt by the fœtus, as it is not accustomed to it, and as there is an essential difference between these stimuli, and those to which it had been previously subjected. It is then that the remarkable sympathy which connects the skin with all the other organs, becomes especially necessary. Every thing within soon perceives the new excitements that are applied without. It is these excitements, those of the mucous surfaces at their origin and those of the whole of the bronchia, which especially bring into action many organs hitherto inactive. There happens then, what is observed in syncope, in which respiration, circulation, the cerebral action and many functions suspended by the affection, are suddenly roused up

by external friction, by the irritation of the pituitary membrane, &c. The phenomena are different, but the principles from which they are derived in both cases are the same.

Then the organic sensibility is also raised. Transpiration is established. The skin begins to be an emunctory of different substances, which it did not before throw out; it becomes also capable of absorbing different principles applied to its surface. The skin of the fœtus is hardly ever the seat of any kind of eruptions; then pimples of different kinds frequently appear.

All the parts of the cutaneous organ do not however appear to be raised to the same degree of organic sensibility. For a long time after birth the skin of the cranium appears to be the centre of a more active life; it becomes the frequent seat of many eruptions, all of which denote an excess of the vital forces. The different kinds of scurf with which it is covered do not appear elsewhere. In this respect, the skin of the cranium follows, like the bones of this part and the cerebral membranes, the early development of the brain, which, on this account is the seat of diseases in infancy more than at any other age.

The skin of the face seems to be sometimes in less activity. In the first months after birth, it has not that bright colour which it will afterwards have upon the cheeks, and which does not commence until the development of the sinuses and dentition bring to this part more vital activity for the nutritive work. It is also towards this period that the eruptions of which this part of the cutaneous system is especially the seat, like those of the small-pox, measles, &c. begin to take place.

For a long time after birth the skin still preserves a remarkable degree of softness; a very great quantity of gelatine enters it; this substance is obtained from it with great ease by ebullition, which, continued for some time, finally melts this organ entirely. The fibrous part noticed

by Seguin, is in very small quantity. I think it is this predominance of the gelatinous portion of the skin, which renders that of young animals easy of digestion. We know that in calves' heads, roasted lamb, and small sucking pigs, prepared for our tables, it presents an aliment which the digestive juices alter with the greatest ease: whilst that of animals of mature age and especially old ones, cannot be digested by them. The carnivorous species tear their prey, feed upon its internal organs, the muscles especially, and leave the skin. Now what is it that makes the skin of young animals differ from that of old ones? It is because the gelatinous substance predominates over the fibrous in the first, and the fibrous predominates in the second.

The skin of children is gradually thickened; but it is not until the thirtieth year that it acquires the thickness that it is always to have afterwards. Till then the different ages are marked in this respect by different degrees. Take a portion of skin at birth, at two, six, ten, fifteen, twenty years, &c. you will see these differences in a remarkable manner. The more its thickness increases the more compact it becomes; it is because the fibrous substance tends constantly to predominate over the gelatinous.

As we advance in age, the adhesion of the internal surface of the dermis with the subjacent cellular texture becomes much greater. It is more difficult to detach one from the other. On the external surface the wrinkles of the face are gradually formed. Smiles and tears agitate the face of the infant the most. One is the expression of the happiness, the other of the uneasiness which all its passions produce in its mind. Now the wrinkles which weeping occasions on the eyelids are marked in rather a more permanent manner, either because weeping is more frequent than smiling, or because continual winking adds to the motion which weeping produces, or because less fat is

found in this place. As smiling is on the one hand more rare, and on the other much fat puffs out the cheeks of the infant, the perpendicular wrinkles formed by the muscles of the face, which in this motion separate transversely the features from within outwards, are much slower in forming. Besides, the nursing of the infant, which requires the contraction of its face from without inwards, opposes their formation. The wrinkles of the forehead are always very slow in forming, because the motions which contract the eyebrow, and those which wrinkle the forehead, are rare in the infant, who has hardly any of those dark passions which these motions serve to depict.

The growth of the dermoid system has not remarkable revolutions like that of most of the others; it goes on in an uniform manner. At the period of the growth of the hairs, it does not change, because this growth is absolutely foreign to it, these productions only passing through it. At puberty it increases in energy like all the other systems. Until then sweats had not been very copious; for, other things being equal, we may say that children sweat less in general than adults, and that the residue of their nutrition passes rather by the urine, which is probably the reason why they are so remarkably disposed to calculi. Beyond the twentieth year we begin to sweat more, and until old age, especially in summer, the fluids appear to go out in this way.

III. *State of the Dermoid System after Growth.*

After growth, the skin continues for a long time to have great activity; the excess of life which animates it, renders it capable of influencing with ease the other organs if it be but a little excited. Hence the disposition to pneumonia, pleurisy, &c. from the action of cold on the skin in sweat, a state in which it is more disposed to exert an injurious influence upon the internal organs, because

its forces are more excited. As to the different affections which result from this influence, they depend upon the internal organs upon which it is directed; so that the same sympathetic irradiations going from the skin, will produce sometimes an affection of the abdomen, sometimes a disease of the thorax, according to the age in which the abdominal or pectoral organs, predominating by their vitality, are more disposed to answer to the influence directed in general upon the whole economy.

The skin becomes more and more firm and resisting as we advance in age, as the fibrous substance is constantly tending to a predominance over the gelatinous. Less blood seems to be carried to it. It becomes less and less disposed to eruptions, so common in youth and infancy, &c. I will not speak of its other differences; for all that we have said of it in the preceding articles relates especially to the adult age.

I will only observe that if, during the greatest part of life, the skin be so fruitful a source of diseases, and the various alterations it experiences produce so frequent disorders in the internal organs, it is only owing to the varied causes of excitement to which it is every instant subjected. If the glands, the serous surfaces, &c. have an influence less frequently upon the other organs, it is because being deeply situated, and almost always in contact with the same excitants, they are not subject to so many revolutions in their vital forces. The secreted fluids and those exhaled in the serous and synovial systems are not, for the same reason, so much subject to those considerable increases, and those sudden suppressions which so frequently happen to the sweat.

Observe that society has also multiplied to a great extent the injurious excitements to which the skin is subjected. These excitements consist especially in the rapid passage from heat to cold, which makes the latter act very powerfully upon the cutaneous sensibility, which

like that of all the other systems, answers so much the more to excitements made upon it, as they are different from those, whose action they had previously experienced. In the natural state, there is only the succession of the seasons; nature knows how to connect insensibly heat with cold, and to make the transition but rarely abrupt. But in society, the different garments, the artificial degrees of temperature of our apartments, degrees differing at first from that of the atmosphere, then varying greatly from each other, so that the same man who in winter enters thirty apartments, is often subjected to thirty different temperatures; the hard labour in which most men are engaged, and which makes them sweat copiously, every thing incessantly presents numerous causes which make the vital forces of the dermoid system vary rapidly. Thus the bronchial mucous surface is constantly in contact in cities, with a thousand excitements that are continually renewed, and with which the air is not charged in a natural state. Thus the alimentary substances, continually varying in their composition, temperature, &c. change the excitement of the gastric mucous surface, and are the source of many affections, from which most animals are exempt by the uniformity of their food.

If the skin and the mucous surfaces were always kept at the same degree of excitement by the constant uniformity of the stimuli, they would certainly be a much less fruitful source of diseases, as is clearly proved by the fœtus, which is hardly ever sick, because all the external causes which act upon its mucous and cutaneous sensibility, as the heat, the waters of the amnios and the parietes of the womb, do not vary until birth. At this period, animals brought into a new medium, find many more varieties in the stimuli which act upon them, even in a natural state and far from society; thus their diseases are naturally much more frequent after than before birth. In society, in which man has increased four, six and even

ten times the number of the stimuli which affect the surfaces destined to be in contact with the external bodies, is it astonishing that the diseases should be so disproportioned to those of animals?

IV. *State of the Dermoid System in Old Age.*

Towards the decline of life, the dermoid system becomes more and more firm and compact; it is softened with great difficulty by ebullition. The gelatine, which it yields, is less abundant and more hard and consistent. I think it would not be fit to make any kind of glue, even the strongest, unless mixed with that of adult animals. Its yellowish tinge becomes very deep. When it is cooled, it requires a much stronger and more durable fire to melt it; the fibrous portion of the dermis which does not melt or at least resists for a long time, is infinitely greater in proportion. It is like the bones in which the gelatinous portion is in an inverse ratio, and the earthy portion in a direct ratio to the age.

The dermoid texture becomes then like all the others, dense and stiff; it is not proper for our food, the teeth cannot tear it. Prepared with tannin, it is more resisting and less pliable, and cannot on that account serve for the same purposes as that taken from young animals. Every one knows the difference of the leather of calves and oxen, especially when the latter are old. This difference is owing first to the thickness, which being much greater in the second than the first, does not allow it to be so easily bent in different directions; and then to the nature of the texture itself. Cut in two horizontally a piece of the leather of an ox; each half will be as thin as a piece of calves skin, and yet it will be less pliable. I do not estimate here the varieties which may depend on the greater or less quantity of tannin that may be combined with it: I suppose the proportions to be all equal.

Submitted to dessiccation, the human dermoid texture becomes much more stiff in old age than in the preceding ones. Maceration softens it with more difficulty. The hair of a child falls out much sooner by it than that of an old person ; thus it requires longer to clean the skins of old animals than those of young ones ; tanners know this very well. I would remark upon this subject, that the skins of animals, having more hairs pass through them, exhibit in comparison with that of man, an innumerable quantity of little pores on their external surface ; which favours in them on this surface the action of tannin, which insinuating itself into the dermoid spaces and filling them completely with a new substance formed by the combination of tannin with gelatine, occupies entirely the texture of the spaces. The previous maceration to which the skin has been exposed, favours not only the removal of the hairs, but facilitates also to a great degree the entrance of the tannin, by separating the fibres of the spaces, by making them larger, and increasing the size of the external pores.

The more we advance in age, the less is the quantity of blood that penetrates the skin. The redness of the cheeks disappears in old people. We no longer see then the rosy complexion of the young man and even of the adult, and which arose from the vessels winding through the cellular texture of the spaces of the chorion.

The continual pressure of external objects increases then remarkably the adhesion of the subjacent cellular texture to the dermis. They are separated from each other with great difficulty by carrying the edge of a scalpel over the internal face of the chorion ; a circumstance which is owing also to this, that the cellular texture having become more dense, is less easily torn ; for this tearing is then necessary, considering the continuity of the sub-dermoid layer with that which enters the spaces.

The exterior of the skin is uneven and rough. All the wrinkles of which we have spoken become infinitely more evident; many belong exclusively to this age.

The vital forces of the dermoid system are more weakened in old age than those of most of the others, because it is more excited during life by external bodies. Most of these bodies then make no impression upon it. The habit of feeling has blunted the animal sensibility. The touch is exercised but rarely; for, as I have observed, this sense requires to put it in action, the previous exercise of the will. We touch, because we have previously seen, heard, tasted, &c. in order to correct or confirm our other sensations; now the old man, to whom every thing around is known, to whom nothing is new, is induced to touch nothing. Compare in this respect the two extreme ages of life. The infant, to whom every thing that strikes his eyes, his ears, his nostrils, &c. is unknown, who finds in every thing that surrounds him new objects of sensation, wishes to touch and lay hold of every thing. Its little hands are in continual agitation. To touch is a pleasure to him, for every new object of sensation is agreeable. If in his last years, man was transported into the midst of objects that never before struck his senses, he would oftener exercise his touch; but none of those things excite him among which he has always lived. Hence why old age is not the age of enjoyments. In fact all our pleasures are almost relative; we have but little that is absolute; now as habit blunts all the relative pleasures, which cease because they have existed, the more the sensations are accumulated by time, the less there are of new ones left to be experienced, and the more are the sources of happiness dried up. For a contrary reason, the happiest age is infancy, because it has before it the whole field of sensations to go over. Man at every step of his career leaves behind him a cause of his enjoyments. When arrived at the end he finds only indif-

ference, a state very suitable to his situation, since it diminishes the distance that separates life from death.

The organic sensibility of the skin is not less blunted in old age, than its animal sensibility; hence the following phenomena; 1st, contagious miasmata are absorbed with difficulty at this age; almost all pass over the cutaneous surface with impunity. 2d. The exhalation of sweat is uniformly less; it is hardly ever subject to those great increases, that are seen in the adult. 3d. The oily fluid is also furnished in much less quantity; hence the constant dryness of the exterior of the skin, the cracking of the epidermis in some cases, &c. 4th. All the diseases which suppose an increase of this organic sensibility are much more rare. Erysipelas and the different kinds of eruptions are a proof of it. When these affections take place, they have a character of remarkable slowness. 5th. The skin resists external cold much less; it loses easily the caloric of the body, which always tends to escape in order to be in equilibrium with that of the surrounding medium; thus old people are always fond of heat. 6th. I am well persuaded that the skin would resist also less, at this age, a degree of temperature greater than that of the body, and as it permits the internal caloric to be easily lost in a colder medium, it would allow the external to penetrate in a warmer one. It would be very curious to repeat, on the two extreme ages of life, the experiments of the English physicians.

EPIDERMOID SYSTEM.

IF we examine attentively, it is easy to perceive the immense difference there is between the preceding system and this, which physiologists have considered as one of its dependancies. Organization, properties, composition, functions, growth, &c. every thing differs in the two. By explaining these, the line of demarcation that separates them will be perceived.

I rank in this system, 1st, the external epidermis ; 2d, that which is spread upon the mucous system, or at least upon one of its parts ; 3d, the nails. Though these last differ very much from the epidermis in their external appearance, yet they resemble it in so many respects, that it is difficult not to place them in the same system. In fact the nails serve as an epidermis for the skin which is subjacent to them ; they are continued with that of the fingers in an evident manner, are detached and regenerated during life with the same phenomena. The composition appears to be very analogous. The kind of excrescences is the same. After death, the nails are detached by the same means as the epidermis, and then make, as it were, a part of it.

ARTICLE FIRST.

OF THE EXTERNAL EPIDERMIS.

The external epidermis is a transparent membrane, more or less thick, according to the regions in which it is examined, covering everywhere the skin, and receiving immediately the excitement of external bodies which would act too powerfully upon this.

I. *Forms, Relations with the Dermis, &c.*

We see upon the epidermis the same wrinkles as upon the skin, because being exactly contiguous, both wrinkle at the same time. Different pores open on its surface after having passed through it. Some transmit the hairs; these are the most apparent; others give passage to the exhalants. We do not see these in the natural state, because their course is oblique, and they open between two small layers, which, being in contact with each other when we do not sweat, conceal their termination. But if, the skin being very dry, we suddenly sweat, as after drinking tea, then the little drops which escape from the whole cutaneous surface, not having had time to run together, but remaining separate, we see, by the places where they are, the orifice of the exhalants. Besides, if we examine against the light a considerable portion of epidermis, its transparency allows us to see many small pores separated from each other by interstices, and which pass through it in an oblique direction. It is only in the soles of the feet and the palms of the hands that we cannot make this observation, which is owing to the thickness in those parts. It is impossible to distinguish in

these pores the absorbent orifices from those of the exhalants, even when mercury enters the first by friction.

The internal surface of the epidermis adheres very closely to the skin. The means of union are at first the exhalants, the absorbents and the hairs, which in passing through the first, adhere to it more or less, and thus fix it to the second, from which they arise. By separating the epidermis by maceration, which is the most proper means, we see on its internal surface many small elongations of greater or less length, and which, when examined attentively, appear to be nothing but the broken extremities of exhalants and absorbents. In fact these little elongations which are easily raised up, and which then appear like small ends of thread when they are of some size, but which exhibit only inequalities when they are left very short, have all of them an oblique course, and terminate in the pores which, we have said, pass through the epidermis to go to its surface. Their existence is sufficient, at the first inspection and without the aid of a microscope, to enable us to distinguish the internal from the external face of this membrane. The spaces that separate them are more or less large. About these spaces, the adhesions are less. It is at this place that the small epidermoid vesicles are formed with which the skin is covered when plunged into boiling water. The depressed interstices, which separate these vesicles, are the places where the exhalants are and which have prevented the epidermis from being raised up. When ebullition is long continued, they are detached also.

We cannot doubt then that all these vascular elongations serve powerfully to unite the epidermis to the chorion. How is the adhesion formed in their interstices? I know not; but it exists, though it is less evident. The cellular texture, as I have said, appears to take no part in it.

Every one knows that many causes destroy the adhesions of the epidermis, and raise it up. These causes are,

1st, every severe inflammation, whatever may be its species. We know that after erysipelas, phlegmon, biles, and cutaneous eruptions of different natures, the epidermis is always detached; there is then no fluid that raises it up. The exhalants cannot furnish it, as they are full of blood; it is dry when detached. 2d. Various cutaneous eruptions, which have not an inflammatory character, as herpes, &c. also detach the epidermis at the place where they are. It most commonly comes off then in the form of dry scales; hence no doubt the idea of some authors who have attributed to it a scaly structure, which neither observation nor experiment upon the epidermis in the natural state have proved. This pealing off in scales is owing to the same cause precisely as the formation of vesicles which take place the instant after the skin has been plunged into boiling water, viz. to the greater adhesion of the exhalant vessels which go to the epidermoid pores. Observe in fact that it is always in the space between these pores that the scales are produced, which do not exist in nature, but which arise only from the manner in which the membrane is raised up. For example, when herpetic eruptions take place on the chin, the pores through which the hairs pass are not detached; it is only the epidermis in the space between these pores; now as these are very near together, these scales are extremely small; they are almost like dust. 3d. Whenever the epidermis is raised up by cutaneous inequalities, the least friction detaches it from these inequalities. Hence why, after strong dry frictions, a rough skin becomes scaly, whilst a smooth one experiences no alteration; it is this even, which in the external appearance, contributes much to the ugliness of the one and the beauty of the other. 4th. After idiopathic fevers, and even many affections of the internal viscera, the skin which has felt the sympathetic influence of the disease, becomes the seat of an alteration which without having any external sign, is sufficient to

break the union of it with the epidermis, which is everywhere raised up. 5th. We know that the action of a blister, which draws a large quantity of serum to the external surface of the chorion, breaks off the exhalants which go from it to the epidermis; so that this serum is effused under it and forms a more or less considerable sac. The water does not escape through the open pores, because their oblique course through the epidermis makes their parietes, when brought in contact with each other by the pressure of the water, form an obstacle to it. It is for the same reason, that though these pores may be very evident, as I have said, in a separate portion of epidermis when examined against the light, this portion will support mercury, without giving passage to its particles. 6th. Most of the preceding means, which produce their effect only by an alteration of the vital forces, have no effect in raising the epidermis in the dead body. Putrefaction, maceration and ebullition are those by which it is effected. All act by breaking the elongations which extend from the dermis to the epidermis, though the mechanism of this rupture is not exactly known.

II. *Organization, Composition, &c.*

Authors have made many conjectures upon the structure of the epidermis, which it would be useless to relate here. I shall only speak of what accurate observation demonstrates. Its thickness is in general very uniform in all the parts. It has not appeared to me to be increased or diminished, according to the varieties of thickness of the skin on the back, the abdomen, the extremities, &c. It is only on the soles of the feet, the palms of the hands and the corresponding face of the fingers, that this thickness becomes greater. It is even so great in these places, that there is no proportion between them and the other parts of the body as it respects this mem-

brane; it is especially towards the heel that it exhibits this character. This excessive thickness appears to be owing to different layers which are applied upon each other, and which seem to be superadded to the layer of the ordinary epidermis; but there is also a real difference, though but little known, in the organization; for example, when the epidermis has been removed from these parts by maceration, we cannot see, as in the others, those small appendices or inequalities regularly scattered over it, and which are the remains of the broken exhalants. In these places these vessels are torn smoother on the internal surface of the epidermis, on which are seen only the traces of the wrinkles of which we have spoken.

I attribute to this excessive thickness of the epidermis of the soles of the feet and the palms of the hands, the difficulty and oftentimes impossibility of making blisters act in these places, on which I have often applied them there, because I thought that the sensibility being greater, they would produce more effect in some diseases. The failure of my attempts has compelled me to renounce them.

This thickness takes from the epidermis the transparency it has in the other parts; it is whitish and opake even on the hand and the foot. Thus the epidermis which, in negroes not being coloured, allows the blackness of the subjacent reticular texture to be seen, conceals in part this blackness in these places. I have observed however, by means of maceration, that the less deep colour of the soles of the feet and the palms of the hands depends also in this race upon this, that the reticular texture is really less coloured. We might say that every thing relates to animal sensibility in this region, the capillary net-work of which appears to be less, and in which all the phenomena that are derived from organic sensibility are much less active.

In examining in this relation the hand and foot of a negro, I have been led to make upon the colour of the

reticular body some other experiments, which form a short digression. 1st. By plunging into boiling water a piece of the dermis taken from any part it becomes twice as black, almost immediately ; which is probably owing to this, that the fibres in approximating by the horny hardening, bring together the colouring particles, whence arises a deeper black. This phenomenon is very striking, when the piece plunged into the water is compared with one that has not been. 2d. Maceration for a month or two, sometimes removes the epidermis without the reticular body, the seat of colour, and sometimes detaches the whole together. 3d. Being immersed for some days in cold water produces no sensible effect. 4th. Long continued stewing hardly changes at all this colour, after the deep tinge that has been suddenly given to it. Only by scraping with a scalpel the external surface of the skin which is then reduced to a kind of gelatinous pulp, we easily detach the coloured reticular body from it, which however always remains adherent to a small portion of the chorion. 5th. Sulphuric acid, which reduces the skin like all the other organs to a kind of pulpy state, also enables us to remove this coloured portion easily, which is detached in separate pieces, but the shade of which is hardly altered at all. 6th. Nitric acid, though very much weakened, does not facilitate so much the removal of this coloured portion. It yellows the internal surface of the skin and the epidermis ; but it has appeared to me to produce but very little effect upon the blackness of the reticular body. 7th. A portion of the skin of a negro, immersed for twenty-four hours in a solution of caustic potash, has not appeared to me to have undergone any alteration in its colour. I have made the same observation when I used a weaker solution. 8th. Putrefaction detaches the coloured portion of the skin, sometimes with the epidermis, sometimes alone, but it does not alter its colour. I have not employed other agents to ascertain the nature

of this colour of the skin of negroes. Let us return to the epidermis, which we have for a moment lost sight of.

Where it is very thick, as on the concave surface of the foot and the hand, we see that it is evidently formed by layers added to each other, and which are separated with difficulty, because their adhesion is so intimate. Everywhere except in the foot and the hand, there is but a single layer; no fluid penetrates the epidermoid texture. Cut in different directions either in the living or dead body, it allows nothing to ooze through it. Their scales are always dry; no blood vessel exists in them. The absorbents and exhalants only pass through it without anastomosing, without winding on its interior before opening on its surface, as happens in the serous membranes, which on this account become black by injection, though but little blood appears to enter them during life. The epidermis on the contrary is never coloured by this means, even when the injection, being very fine and driven with success, oozes out on the external surface of the skin. Thus, in inflammation, in which all the cutaneous exhalants are full of blood which they do not contain in the natural state, this fluid never enters the epidermis, which is uniformly disconnected with all the diseases of the subjacent reticular body, and which, being only raised up by inflammation, is detached and afterwards renewed.

The epidermis has evidently no nerves. It is also destitute of cellular texture; thus fleshy granulations, which are formed by this texture, never arise from this membrane; the excrescences of which it is the seat have not the character of the different tumours which the cellular texture especially contributes to form, such as fungi, schirri, &c.

From this it is evident that none of the general systems common to all the organs, enters into the epidermoid system. It has not then the common base of every organized part; it is as it were inorganic in this respect.

The epidermoid texture exhibits no fibre in its interior ; it has in general but little resistance, and is broken by a slight distention, except on the fingers and the hand where it resists more, on account of its thickness.

The action of the air hardly alters it at all. Only when it is exposed to it after having been removed in the form of a large layer, it hardens a little, becomes a little more consistent, and is torn with less ease. It is of all the organs, next to the hair and the nails, that which drying changes the least in the natural state. It also becomes a little more transparent by it; but resumes its ordinary state when again immersed in water, which proves that it contained a little of it in this state. The action of the air, which is so quickly efficacious upon the skin in putrefaction, leaves it then wholly untouched. It is only raised up, but does not itself putrify. Separated in this way and washed to cleanse it of the fetid substances that might adhere to it, it exhales no bad odour. Kept a long time in moist air, alone and well separated from the neighbouring parts, it does not alter. It is, next to the hair and the nails, the most incorruptible of the animal substances. I have preserved a foot found in a cemetery, the skin and fat of which are transformed into a fat, unctuous and hard substance, which burns in the candle, whilst the epidermis, which is very thick, is hardly changed at all in its nature.

The action of water upon the epidermis can be considered under many relations. 1st. During life it whitens it, when it is some time in contact with it, and at the same time wrinkles it at different points. We often see this phenomenon in the hands on coming out of a bath ; but it is particularly evident after ten or twelve hours application of an emollient cataplasm, in which the action of the farina is nothing, and in which it is the water that produces the whole effect. This whiteness of the epidermis appears to be then owing to its having really imbibed

some of the fluid. It is the same phenomenon that takes place on the serous, fibrous, membranes, &c. which, having become artificially transparent by drying, whiten again when immersed in water. Here the epidermis, naturally transparent, whitens by the addition of this fluid. In this state it renders the sensibility of the papillæ infinitely more obtuse ; I have often made the experiment upon myself, by applying a cataplasm in the evening and removing it the next morning. When the water is evaporated which the epidermis has imbibed, it again becomes transparent, wrinkles, resumes its natural state, and allows the sensibility of the skin to be again apparent. This phenomenon is especially observed upon the epidermis of the foot and the hand, for it is not often as sensible elsewhere. 2d. In the dead body, the epidermis separated from the skin, and immersed in water, whitens also, but does not wrinkle. Left to macerate in water, it does not undergo any putrid alteration. Only there rises on the surface of the fluid many particles, which being in juxtaposition, form a whitish pellicle of the nature of which I am ignorant. At the end of two or three months, the epidermis thus left in water, softens, does not swell, and is torn with great ease ; it is not reduced to a pulp analogous to that of the other organs thus macerated. 3d. When stewed, the epidermis does not undergo, at the instant of ebullition, a horny hardening like all the other organs. Hence why, whilst by this horny hardening the skin is much diminished in extent, the epidermis which remains the same is obliged to be folded in different directions. When the ebullition is continued, this membrane becomes less resisting and breaks with great ease, but is never reduced to gelatine, does not acquire a yellowish colour, and does not become elastic like the organs which furnish much of this substance; besides, we know that the epidermoid texture does not combine with tannin, and that it is even an obstacle to it when it tends to pene-

trate the skin. After long stewing, the different layers which compose the epidermis of the palm of the hand, and especially that of the sole of the foot, are separated with great ease; this is the best way of seeing this lamellated structure. Between these layers there is often formed on the foot small vesicles filled with serum.

Caloric produces upon the epidermis phenomena wholly different from those which the other systems experience from the contact of this substance. A portion of this membrane well dried by the action of the air, and exposed to the flame of a candle, 1st, does not undergo hardly at all the horny hardening, as a portion of skin does when thus treated; 2d, it exhales a fetid odour analogous to that of burnt horn, and different from that of all the other textures when subjected to the same experiment; 3d, it burns with great ease, which does not take place with any of the preceding systems when dried; it is often even sufficient to put the fire to it at one end to consume it entirely; 4th, at the place of the flame we see a blackish bubbling fluid, from which often escapes little burning drops, and which is very analogous to that of a feather when burnt. It is evidently an oil which supports the combustion by its great abundance, and which does not appear to be found in as great quantity as in the hair and the nails. This oil deserves particular examination; it is that which gives out in burning so disagreeable an odour, and which forms those burning and whitish drops of which we have spoken. It appears to be of the same nature as that which Bertholet obtained from the hair in so great a proportion. After combustion there is left a blackish charcoal, which I have not analyzed.

Light does not appear to have a great action upon the epidermis, which I have found of the same colour, in portions of skin blackened by it, and in those which have been sheltered from it.

Nitric acid yellows very sensibly the epidermis, more even than any other animal substance; but it does not dissolve it without great difficulty. The sulphuric on the contrary acts very powerfully upon it, especially when it is a little concentrated. When it is drawn out after having been a short time plunged in, it is found to be very thin, extremely transparent, and almost similar in this respect to the pellicle that is taken from an onion. This curious phenomenon has often struck me. When left too long in the acid, the epidermis is finally entirely dissolved in it.

The alkaline lies dissolve this membrane, but with difficulty. Pure alkali has a very prompt action upon it.

Alkohol has no influence upon the epidermis.

III. *Properties.*

The epidermis has but very little extensibility, since the least cutaneous tumour can tear it and raise it up in scales, as in herpes, or in larger pieces, as from a blister. Yet it is not entirely destitute of it, as the vesicle proves which is formed by this last. Its contractility of texture is nothing. We observe, that when no longer distended, this bladder remains flaccid and never contracts.

Every kind of animal sensibility is foreign to the epidermis. We know that it can be pricked, cut or torn, without being felt. It is especially on the palms of the hands and the soles of the feet that these experiments are easily made. The thickness of this membrane is such in this place, that we can remove layers of it, as we see done by those who try the edge of an instrument, that it is possible even, as most cooks do, to put it in contact with live coals, and that it is not impossible to carry a red hot iron over it. It is by this insensibility that it blunts the action of the acids, the caustic alkalies, and of all the powerful stimuli, which when in contact with the dermis laid bare by a blister, give excessive pain.

The epidermis differs from all the other organs that are destitute, like it, of animal sensibility, as the cartilages, the tendons, the aponeuroses, &c. in this, that it is never capable of acquiring it; whereas the others, if a little excited, often take a degree of it superior to that of the organs which naturally possess it. Whence does this arise? From the fact, that in order that the animal sensibility may arise in an organ it is necessary that the rudiments of it should be there already, and that this organ should enjoy organic sensibility, which, when raised by irritation is transformed into animal; now the epidermis appears to be destitute also of this last property, as well as of insensible contractility. In fact, 1st, there is no sensible circulation in it. 2d. The exhalants and absorbents which go through it, are wholly foreign to it. 3d. No morbid phenomenon, that supposes organic sensibility, appears in the epidermis. It does not inflame; it is passive in all cutaneous affections, and never partakes of them notwithstanding its continuity. The impossibility of inflaming makes it an obstacle, wherever it exists, to cutaneous adhesions, which cannot take place until it is removed. Its internal surface, raised by a blister, and reapplied to the dermis by the evacuation of the serum of the vesicle by means of a small puncture, never unites again. 4th. The excrescences of which it is the seat, as corns, some indurations, &c. are inert and dry like it, and without internal circulation; if they are painful, it is from the pressure upon the subjacent nerves, and not from themselves. 5th. No sensible operation is performed in the epidermis; it is worn incessantly by friction, like inorganic bodies, and it is afterwards reproduced.

This continual destruction of the epidermis has not sufficiently arrested the attention of physiologists. The following are the proofs of its reality; 1st, if with the blade of a knife, we scrape strongly its external surface, a large quantity of powder is removed which sulphuric

acid easily dissolves, and which is greyish. The epidermis whitens a little in this place, then resumes its colour, especially if it is moistened. By scraping again, we do not remove any more powder, it is necessary in order to obtain it, to wait twelve or twenty hours. 2d. This substance becomes superabundant, when the skin has not been washed for a long time. Hence why those who soak their feet that have not been cleaned for a long time, detach so great a quantity of it. It is especially on the sole of the foot that this substance is formed in abundance. We often observe in dead bodies that it forms almost a layer in addition to the epidermis, but which is very distinct from it, and can be removed with ease. I attribute this circumstance to the thickness which the epidermis has in this place. We should no doubt find as much upon the hand, were it not for the continual friction of this part. We see it often on the patients in hospitals, after remaining a long time in bed without having been cleansed.

Water naturally removes this substance, that is produced by the destruction of the epidermis, and, which, mixing with the residue of transpiration, that the air cannot carry off by evaporation, renders bathing, as I have observed, a natural want. Though it may be neither exhaled nor absorbed, and though its production may appear to be owing to mechanical friction, yet we can, in its relation, consider the epidermis as an emunctory of the body, since it is renewed by a substance coming from the dermis, as fast as it is removed.

It is evident, as the epidermis has no vital properties, that it cannot be the seat of any kind of sympathies, which are aberrations of these properties. Hence its life is extremely obscure, I doubt even if it possesses vitality. We might almost say that it is a semi-organized body, inorganic even, which nature has placed between external inanimate bodies and the dermis, which is com-

pletely organized, in order to assist their passage and guard against their force.

The epidermis has a property very distinct from those of most of the other systems; it is that of being reproduced when it has been removed. It grows anew and is formed again with an appearance exactly similar to what it first exhibited; it is that which makes it differ from all the other systems, as the cellular, which throw out vegetations when they are laid bare, but which are only reproduced in an irregular manner, and wholly different from their natural state. How is the epidermis thus reproduced? Is it the pressure of the atmospheric air which renders the external surface of the skin callous? Is it the air, which, by combining with the products which escape from this surface, forms a new compound? I know not. What is certain is, 1st, that this production is wholly different from that of the internal organs; 2d, that it cannot take place except upon the skin, and that the fine pellicle that covers all the other cicatrized parts, after a wound with loss of substance, does not resemble it at all and presents even a texture wholly different. Thus this pellicle is not raised up by the different means which raise the epidermis; thus it often becomes the seat of acute sensibility which is never the case with the epidermis. This is what takes place especially in changes of weather, a time in which the cicatrices become, as we know, very painful; I have often observed, that not only the interior, but the pellicle even of the cicatrix are then sensible. Besides, when this pellicle is formed, red blood vessels evidently penetrate it, whilst nothing similar is observed in the formation of the epidermis.

It is this faculty of reproduction which is put in action in many epidermoid excrescences, as in corns, and callosities which have nothing in common but the name with those which form the edge of fistulas, &c. All these excrescences are insensible, without vessels or nerves, of the

same consistence and the same colour as the epidermis; they are often removed from it and afterwards formed again. It appears that external pressure has much influence upon their development; too narrow shoes and the solid bodies which are used on the hands of smiths and other workmen are the frequent cause of them.

I preserved a great part of the skin of a man who died at the Hôtel Dieu, and his epidermis, which was treble the thickness from his birth and even in the womb of his mother, that it is in the ordinary state, had been subject during his life to a continual desquamation which made the whole of it appear as if covered with herpes, though nothing similar to this affection existed upon the dermis, which was perfectly sound. The face alone was exempt from this defect of conformation.

The epidermis is not only reproduced when the whole of it has been removed, but also when the superficial layers alone have been taken away, especially on the foot and the hand on which other layers arise upon those which the cutting has laid bare; which proves that they are not, as has been said, the juices of the reticular body which form it by drying.

IV. *Development.*

Those who have thought that the epidermis is formed by pressure, would be convinced that this is not the case if they would examine that of the fœtus, which is very distinct, more even in proportion than many other systems. We observe it when the skin begins to leave the pulpy state of which we have spoken. At the end of the fifth month, it has proportions analogous to those which it will afterwards exhibit. It is very thick on the soles of the feet and the palms of the hands, and very thin elsewhere; it is easily detached by all the means we have pointed out. We know that in a fœtus that has died and

become putrid in the womb, it is found in great measure detached. At the place of the umbilical cord, it is continued in an insensible manner with the skin.

At birth, though it is in contact with a fluid that is new to it, it does not undergo a great alteration; which proves that the air has little or no agency in its formation. It becomes thicker as we advance in age, and follows, in this respect, nearly the same proportions as the skin. Beyond the twenty-sixth or thirtieth year it increases no more. I have often raised up in many places the epidermis of an old person; it has not appeared to me to differ much from that of the adult; it is a little more subject to scale off and it is a little thicker. In some miserable objects which come to hospitals, there is often vermin in cracks of the epidermis, whose layers are afterwards separated by them and in which they live; so that I have seen the epidermis in this way conceal thousands of little animals, which were evidently found between the layers of this membrane, and which were not upon the reticular body and the papillæ. It is the only means that has shown to me the lamellated structure of the epidermis, in any other place than on the foot and the hand, in which I have never seen vermin.

The cracks of the epidermis in old age appear to arise from its dryness owing to the want of exhalation; it is that which renders the skin so rough and harsh. What contributes to it also is, that as it has many inequalities on account of its numerous folds, frictions being more felt in these prominent places, make the epidermis scale off; thus in the adult the same cause renders it scaly on a tubercular skin, whilst a skin that is smooth and well distended with fat, undergoes every kind of friction without desquamation.

ARTICLE SECOND.

INTERNAL EPIDERMIS.

All authors have admitted the epidermis of the mucous membranes. It appears that most have believed that it is only this portion of the skin which descends into the cavities to line them. Haller in particular is of this opinion. But the slightest inspection is sufficient to show, that here as upon the skin, it forms only a superficial layer over the papillary body and the chorion. Boiling water which detaches it from the palate, the tongue and the pharynx even, enables us to see the two other layers.

I. *Epidermis of the origin of the Mucous Surfaces.*

The epidermis is very distinct upon all the origins of the mucous system, upon the glans, the entrance of the anus, the urethra, the nasal fossæ, the mouth, &c. It is demonstrated in these places by the excoriations that take place there, upon the lips especially, by dissection with a very fine lancet, by the action of boiling water, maceration, putrefaction and even epispastics, as is proved by the fact that the ancients employed this method to make the edges of a hare-lip raw. The delicacy of this epidermis is much greater than on the skin; and as it is more in the interior this delicacy increases. It is to this circumstance that must be attributed the ease with which different remarkable modifications are produced through this membrane, when in galvanic processes, we arm with zinc the surface of the tongue and with another metal the mucous surface of the conjunctiva, the pituitary membrane, the surface of the rectum, the gums, &c. and bring in mediate or immediate contact these different metals.

The mucous epidermis is quickly reproduced when it has been removed. Destitute of every kind of animal and organic sensibility, it is in this respect, destined like the skin, to defend the very sensitive papillary body that is subjacent to it. It is to its presence upon the mucous membranes, that should be in part attributed the faculty they have of being exposed to the air, and even to the contact of external bodies, without exfoliating or inflaming as in preternatural anus, prolapsus of the rectum, &c.; whilst the serous membranes cannot bear this contact with impunity.

Besides, the nature of the mucous epidermis is the same as that of the cutaneous. Submitted to the action of the same agents, it gives the same results. The excrescences formed on its surface are also analogous, though much more rare. It becomes callous by pressure. Chopart relates the case of a shepherd, whose urethra became so, from frequently introducing a small stick to procure pleasure. We know the density that this covering has in the stomach of the gallinaceous animals, and in certain cases in which the mucous membranes come out of the body as in prolapsus of the rectum, the vagina, the womb, &c. Sometimes in those cases the pressure of the clothes produces in this epidermis a thickness evidently greater than what is natural to it; it is this which then makes these membranes lose in part the bright red that characterizes them in the interior.

II. *Epidermis of the deep seated mucous surfaces.*

The epidermis gradually becomes more delicate, and is soon almost insensible, on the internal mucous membranes. 1st. In the stomach, the intestines, the bladder, the gall-bladder, the vesiculæ seminales, in all the excretories, &c. the most delicate instrument cannot raise it up. 2d. In the maceration and ebullition of the mucous sys-

tem of these parts, I have never seen the epidermis raised up on its surface. 3d. I have drawn out of the abdomen of a dog a portion of intestine; its mucous coat has been laid bare by an incision, and I have applied an epispastic to it; more redness was seen upon the free surface of this coat, but no pellicle was raised up from it. 4th. We do not see in preternatural anuses, complicated with inversion, excoriations analogous to those of which the surface of the lips, that of the glans, &c. are the seat. 5th. I have already had frequent occasion to open bodies affected with acute or chronic catarrhs of the intestines, the stomach, the bladder, &c.; now I have never seen the epidermis separated by inflammation, as happens after erysipelas, phlegmon, &c. upon the cutaneous organ. 6th. We do not see upon the deep seated mucous surfaces those exfoliations, desquamations, &c. so frequent upon this after many affections.

From all these considerations it would appear, that the epidermis does not exist upon the deep seated mucous surfaces, and the great quantity of mucous juices constantly poured out by the subjacent glands, supplies its place in defending the papillæ and the chorion from the impression of substances heterogeneous to the economy, contained in the internal cavities. Yet there is a circumstance that would seem to demonstrate the existence of the epidermis upon the deep seated mucous surfaces; it is the separation of preternatural membranes, which are often detached from these surfaces, and which may be considered as a kind of epidermoid exfoliation. Many authors give examples of these membranes formed either upon the bladder and voided by the urethra, or upon the stomach and œsophagus and thrown up by vomiting, or upon the intestines and expelled with the alvine evacuations; Haller has collected many cases. Dr. Montaigu informed me that he saw a membrane vomited up, which formed a sac without a rent, exactly analogous to that

of the stomach whose internal surface it lined. Desault saw a sac almost analogous to the bladder, voided by a patient who was affected with retention of urine.

I confess that I have made no observation on this point, so that I cannot say what is the nature of these membranes. But authors in general agree in attributing to them a soft and pulpy nature, which does not appear to me to accord with that of the epidermis. I have many times seen at the Hôtel Dieu white membranes detached from the œsophagus after poisoning with the nitric acid. But these membranes are evidently the superficial portion of the mucous organ, which is disorganized, and thrown off by suppuration which takes place below. It is thus that cutaneous eschars fall off in the form of membranes from large burns: in this way the osseous layers are formed in necrosis, which are only the superficies of the bone that dies and is detached in a lamellated form.

From this, the existence of the epidermis of the deep seated mucous surfaces appears to me to be very uncertain, and cannot be admitted till a new examination, which will, I think, prove rather against than in favour of its existence. What is the place in which the epidermis terminates that lines the origin of the mucous surfaces, or if it exists everywhere, where does it begin to become no longer apparent from the action of our different reagents? We cannot, I think, determine with precision; it diminishes in an insensible manner, and is lost as it were by degrees.

ARTICLE THIRD.

OF THE NAILS.

All the fingers have at their extremity, on the outer side or that of extension, hard, transparent and elastic lay-

ers, of the nature of the horns of many animals, and which are called nails.

I. *Forms, Extent, Relations, &c.*

The nails of man differ from those of most other animals, in their breadth and want of thickness. The first makes them better adapted to support the extremity of the fingers, which is broader than in most animals for the perfection of touch; the second renders them less fit to serve for defence or as a means of aggression.

Most people cut their nails even with their fingers, so that the length of these bodies which is seen is not what is natural to them. When allowed to grow, they lengthen and turn over on the side of flexion, and cover entirely the lower end of the fingers. This growth has a certain limit which the nail cannot pass, and which it attains when it exhibits at its extremity a cutting and sharp edge. As long as this edge has the appearance of having a part cut off, the nail continues to grow.

We usually think that the habit of cutting our nails is a thing of mere decorum. But if we reflect a little upon society and the numerous arts to which it gives rise, upon the perfection, delicacy, precision and rapidity of the motions which the fingers are often forced to execute, upon the necessity of approximating them, crossing them in a thousand different ways, &c. we shall soon see that this habit is almost inevitably the result of the social state, and what appears to us the effect of fashion is that of necessity. The sense of touch in man in a natural state is coarse and obscure; it is only necessary that he should seize objects destined for his nourishment, his defence, his aggressions, &c. that he should climb especially and attach himself to trees to keep himself upon them; now his nails are for this purpose of great use. What he loses in this respect in society, he seems to gain by the pre-

cision and extent which are added to his touch, and by the faculty which the fingers acquire of distinguishing the most delicate tangible qualities. In the first state, his hands are of great assistance to him in locomotion. In the second, they contribute hardly at all to this use, and they gain in the partial motions of their fingers what they lose in their motions as a whole, which become of less urgent necessity.

The nail has three distinct parts in the natural state; one posterior, concealed on both sides by the integuments; another middle, free only on one side, and the third anterior, without adhesion at either side.

The posterior portion of the nail is nearly a sixth part of its extent. Its convex surface adheres very intimately to the epidermis, which goes in the following manner to fix it. After having covered over the portion of the finger corresponding with flexion, it is reflected upon the concave edge where the skin terminates and where the nail begins to become external; it commonly forms all around this edge a kind of small string that is very distinct and has a small groove in the top of it, and which is evidently composed entirely of epidermis, since we can cut the whole of it without giving any pain, and which is afterwards easily reproduced. After having formed this string, which is in the form of a parabola, the epidermis is again reflected, passes between the skin and the nail, and is glued, if we may so say, to the concave surface of the latter, without being intermixed with it; for we can remove it with ease by scraping with a scalpel. So that the dermis which covers the superior portion is really between two layers of epidermis. After having thus fixed the nail, and having arrived at its posterior edge, the epidermis is continued and identified as it were with this edge, whose evident delicacy and softness approximate it in nature to this membranous layer. Hence it follows that without the adhesion of the epidermis to the nail,

there would be between them, a kind of cul-de-sac. Some authors have thought that the extensor tendon is extended as far; but it is easy to see that it does not go beyond the tubercle which terminates behind the phalanx. The nail does not reach this tubercle, there is a space of three lines between them. The concave surface of the posterior portion of the nail corresponds with the same substance as the middle portion.

This middle portion is bare on its convex surface, which is smooth, whitish behind where this colour forms a kind of half moon, reddish in the greater part of its extent, a colour which is foreign to it and which it derives from the subjacent texture. Upon the sides, the skin covers this surface a little, and terminates afterwards by continuing the concave and free edge of which we have spoken. The epidermis forms also in this place a small string which is continued on each side with that pointed out above; then it unites to the nail and adheres to its lateral edges with which it is identified. The concave surface of this middle portion is fixed in front by the epidermis, which, after having covered the extremity of the fingers, and having arrived at the place where the nail ceases to be free, is separated from the dermis, and adheres to the whole length of the nail in a curved line; then by mixing with it, it seems to form its internal lamina. The dermis on the contrary is continued on the convexity of the last phalanx, has there a remarkable consistence, a reddish appearance, and a texture like pulp and wholly different from what is observed elsewhere; more vessels run through it; there is no distinct space in it, and no elongation goes from it to the surface of the nail of which the epidermis forms a part. We do not see on this surface, as on those of the other parts of the epidermis, those threads, which are the remains of the broken exhalants and of which we have spoken; thus the sweat never passes through the nail. There is neither any oily oozing

upon its surface; whence it follows that water is not formed into little drops on the exterior of its horny laminæ. Hence the nail is evidently insulated from all the other organs except the epidermis, with which it is continued on its concave face and especially on its posterior and lateral edges. Thus observe that when collections of pus or other affections have broken this continuity behind or on the sides, the whole of the nail, though unaffected in the middle falls off.

The free or anterior portion of the nail is of a length which it is difficult to determine. I have never seen it allowed to take its natural growth. I have only observed that if it is permitted to grow to a considerable size, we see evidently that it has a greater thickness than the posterior and middle portion. In general, the thickness, resistance and hardness of the nail increase in a gradual manner from the posterior to the anterior part; we shall now examine to what this is owing.

II. *Organization; Properties, &c.*

In order to observe the organization of the nails advantageously, it is necessary to take those that are very distinct, as those of the great toe, the thumb, &c. We then see evidently that a single lamina occupies the whole of their convex surface. Behind, this lamina exists alone; hence the extreme thickness of the nails at this place. But as we examine towards the front, we see new laminæ successively added to it, on the concave surface; so that the nail becomes successively thicker. These laminæ can be easily raised up layer by layer. The most anterior are the shortest. They often exhibit upon the concave surface of the nail an infinite number of very evident small striæ, all longitudinal and parallel, and which make us attribute to it a fibrous texture. At other times this arrangement is less evident.

What is the nature of the laminæ which form the nails? I believe that they are almost precisely the same as the epidermis. What proves it is, 1st, that the most superficial is evidently continued with it by its edges; there is no intermediate agent between them. 2d. I have already observed that the nails are detached, and then regenerated exactly like the epidermis. They have two modes of increase; one in length, when we cut their extremities; the other in thickness, when we detach only a lamina, which is soon formed again. When the whole of the nail comes off, all the portion of the dermis which covers the back of the last phalanx, contributes at the same time to form it anew by its external surface. 3d. There is the same obscurity in the vitality of the nails as in that of the epidermis. No trace of animal sensibility is discoverable in them. The excruciating pain that is experienced when they are pulled out arises solely from the sensibility of the subjacent pulpy texture; it is from the same cause as in pulling out the hair. There is no organic sensibility, no internal circulation and consequently no heat inherent in the texture of the nails; thus the horns of animals are nearly of the same degree of temperature as the atmosphere, whilst some external productions with evident vital forces, though raised up like horns, have a temperature equal to that of the body. Such are the combs of the cock of our country, and those which are more striking of the cock-turkey. Compare these excrescences with those on the feet of these animals, which are horny, and the difference of temperature is evident. 4th. The nails give out when burning a disagreeable odour, analogous to that of the epidermis under the same circumstances; they exhibit then the same phenomena. Their combustion is supported, like that of the epidermis, by an oil of which they contain a great quantity. 5th. If maceration and stewing do not produce upon the nails that want of consistence, that kind of brit-

tleness, if I may so express myself, which they produce upon the epidermis, it appears to be owing only to their greater solidity. 6th. The action of the nitric, sulphuric acids, &c. has exhibited to me nearly the same phenomena as upon the epidermis.

Every thing then appears to establish the most exact analogy in the composition, organization and properties of the nails and the epidermis. There is no doubt a difference of principles between them, since the appearance is not the same, and since, though many epidermoid layers may be in juxta position as on the soles of the feet and the palms of the hands, they do not exhibit the form and texture of the nails; so that we cannot consider these as mere layers of epidermis applied to each other. Chemists must ascertain what these differences are, which are certainly very slight. Thus nature often employs indifferently the two organs for the same uses; it is thus that on the sole of the foot of man and many analogous species, there is a thick epidermis; whilst on the feet of animals with hoofs, we see a horny substance of the nature of the human nail.

An evident proof of the slight degree of internal motion which is going on in the epidermis and the nails, of the kind of inertia in which they are in relation to the constant motion of composition and decomposition, which constitutes nutrition, and of the insensibility which they exhibit to various excitants, is the ease with which they are penetrated by different colouring substances, and the very long time they retain them. We know this effect with regard to the nails of dyers. Many savage people who paint the face, various parts of the body, and often even the whole of the external surface of the body, preserve for a long time, without a new coat, the colour which they have artificially given themselves. I have removed the epidermis of a portion of skin of the arm of a dead body, which was coloured blue during life: this

colour was not only on the surface of the membrane, but penetrated the whole of it, like a piece of cloth that had been soaked in it. Yet the pores were as evident as before, and the sweat could pass through them; I presume this secretion goes on as usual in savages who paint the skin. Thus the cloth which is immersed in a dye, has not its pores closed by it. I may make use of this comparison, as the epidermis and the nails are really species of inorganic bodies. Lay any organ bare and paint it in this way; the colour, together with the contact of the air will irritate and inflame it, and the suppuration arising from this inflammation will soon throw out the colouring particles, which nutrition would have done, if inflammation had not. There is a means however which can perpetuate the colour, even upon organs, which, very sensible like the skin, are constantly subject to the double nutritive motion; it is that of using the colours with a red hot iron. It is in this way I am convinced that the letters or coloured figures which most soldiers mark upon themselves, with a red hot pin, have their seat not only in the epidermis, but also in the chorion itself.

Development.

The nails have in the fœtus a very considerable consistence, whilst the skin is still pulpy; but their tenuity is then extreme. But they thicken and acquire greater consistence as the fœtus increases in size. They have not at birth a length proportionable to what they are afterwards to have. They do not extend beyond the ends of the fingers which are often much the longest; so that it is not till after birth that they are bent over and exceed the fingers in length, for both of these would be useless in the womb of the mother, as there is nothing there for the fœtus to seize upon. Their transparency allows us evidently to see, at the moment of birth, first the black colour of the blood which before circulated in the arteries, and

then the vermilion colour which respiration suddenly imparts to it. As we advance in age, the nails grow in the same proportions as the epidermis, but they have nothing peculiar in their growth. In old people they become extremely thick.

These organs experience during life those diseases only which are analogous to those of the epidermis. These are excrescences, augmentations of size, &c. and other productions, the texture of which is precisely the same as that of the nail, and in which there is neither more sensibility, nor more circulation, nor more heat, nor more life; a remarkable character which distinguishes them from those tumours which arise upon the other organs with very active vitality, as upon the skin, the muscles, &c. tumours the texture of which is very different from that of the organs which have produced them, and which most usually have properties entirely different. But the epidermoid excrescences are in every respect analogous to the epidermis.

PILOUS SYSTEM.

THE adjective by which I characterize this system, is derived from the latin substantive which signifies the organs of which it is composed. Hair is found less generally upon man than upon most other animals. It forms upon them a kind of covering external to the skin, which, lessening in part the contact of external bodies, makes the cutaneous animal sensibility perform a less important part, and establishes less numerous relations between these bodies and them. External life is then, in this respect, more limited in them than in man, in whom a delicate epidermis and a few hairs thinly scattered over it, separate the organ of feeling from surrounding objects, the least impression of which is felt, and which, owing to this, keep the animal sensibility in permanent activity; thus man is designed to live more without than within himself. The pleasures of reproduction and digestion constitute exclusively the happiness of animals. That of man is in part the result of them; but an order of pleasures wholly different, purely intellectual and in relation only with external sensations, enlarges immensely by its presence, and contracts by its absence, the field of this happiness.

The hair of man covers especially the cranium, some parts of the face, the front of the trunk, the genital organs, the extremities, &c. The quantity varies remarkably, as well as the form, length, &c. In order to form an accurate idea of it, we shall now consider it separately in the different organs, we shall then treat of its general organization, properties and development.

ARTICLE FIRST.

EXAMINATION OF THE PILOUS SYSTEM IN THE DIFFERENT REGIONS.

This system must be considered on the head, the trunk and the extremities.

I. *Pilous System of the Head.*

The head is the part of the body in which this system predominates; it covers the whole cranium and defends it against the impression of external bodies, as the hairy coat of quadrupeds defends them. Thus this part is the least capable of exercising the sense of touch, either from the obscurity of the animal sensibility arising from this hairy covering, or because its convex form allows it to be in contact with external bodies only by a small surface.

The face is less generally covered with hairs, though many are found upon it, especially in men. This part, in which in a very small space are collected the greatest number of our means of communication with external objects, viz. the organs of taste, smell, sight and even

hearing, has but very little to do with the sense of touch, on account of its villous arrangement. Its form is also badly adapted to this sense. The mouth which is flattened cannot be applied to external bodies. Thus whilst the snout which is elongated in most quadrupeds, performs the double function of first feeling all bodies, turning them in various directions in order to ascertain their tangible qualities, and then of seizing them for nourishment, the mouth of man serves only for this last use; it is the hands which are destined for the first. Thus observe that all animals, even the most of those with clavicles, almost uniformly direct their snout towards the earth, whilst the mouth of man is naturally destined to an opposite position.

Of the Hairs of the Head.

They occupy upon the cranium all the space which corresponds with the occipital, parietal, the squamous portion of the temporal and a small portion of the frontal bones. Their limits do not vary on the sides; they always correspond above the ear. Behind, they sometimes go down upon the superior part of the neck; at others, they do not extend beyond the head. In applying blisters on the ligamentum nuchæ, we observe in this respect, almost as many varieties as there are subjects. We know how variable these limits are in front. Sometimes extended lower down, sometimes carried higher up, sometimes describing a curved line, and at others forming a real triangle the anterior point of which corresponds with the median line, they have really nothing constant.

These inequalities alone determine the breadth or narrowness of the forehead, whilst its degrees of inclination depend solely upon the bone which forms it. It is in this way that the hair contributes a little to the expression of the face; I say a little, for it is less to the breadth of the forehead than to its approximation to a perpendicular,

that we attach the ideas of majesty and greatness which characterize heroes and gods. The poets, as we know, have particularly celebrated the forehead of the god of thunder. Observe in relation to this subject that there is a great difference between that which expresses majesty or abjectness in the face, from that which serves there to express the passions. It is the osseous structure of this region and the degree of inclination resulting from this structure, which serve for the first use, and it is especially the muscular motions which contribute to the second. Why? Because majesty, grandeur, &c. are especially connected with the extent of the understanding, and the understanding has its seat in the brain, and because the various capacities of the cranium, which contain this organ, and which correspond with its various degrees of development, have inevitably an influence upon the different dimensions of the face. Now as the bony structure is a thing constant and invariable, the air of majesty or abjectness remains always imprinted upon the face. On the contrary, the passions which especially affect the epigastric organs, which afterwards excite the facial muscles, have necessarily a transitory expression.

The number of hairs is very variable on the same surface. In some people they are very close together and even all touch; in others more thinly scattered, they allow in part the skin of the cranium to be seen in their interstices, a circumstance which is either owing to original conformation, or to a disease which makes them fall out in part. They have, like the nails, a determinate growth which they do not exceed. We know but little of the limit of this growth. Yet we have seen them reach to the waist, the thighs, and the legs even. It appears that in women they have a greater growth; we might say, that nature has compensated this sex in this way for the want of hair in many other parts. Floating upon the shoulders, the breast, the trunk, &c. they form

in the natural state a sort of protection from the injuries of the air and the light. Their extent evidently proves that man was destined to an erect attitude. In fact, in the attitude of quadrupeds, they would trail much upon the earth, and form an obstacle to motion. The hair of no animal, I believe, in a natural attitude retards his progress so much, as the hair of man then would.

Man, who opposes nature in every thing, has made it a habit in most societies to cut the hair, the beard, &c. By common people, it is considered merely a thing of fashion; by the physician, as a practice which has perhaps a greater influence than is thought upon the functions. In fact, in the natural state when the pilous system has once acquired its growth, it no longer exhibits the constant motion of composition and decomposition. On the contrary, in man who cuts it, it is constantly the seat of this motion and of that of growth. This practice perpetuates then the phenomena which take place in them in infancy, and consequently keeps up there a more active work, which perhaps is performed at the expense of that of many other parts.

The natural difference of the hair has much influence upon its length; that which is smooth and curls but little is in general the longest. The more it has the opposite characters, the shorter it is, as is proved by that of negroes and those white people whose hair curls like theirs.

The tenuity of the hair is very great, yet its resistance is in proportion very considerable. There is no part in the economy, not even those of the fibrous system, which can support so great a weight in proportion to its size Thus woven strings of hair would have an enormous resistance, if they were sufficiently long to be employed for different uses.

The colour of the hair varies remarkably according to country, latitude, climate, temperature, &c. This colour

is even, like that of the skin, a characteristic attribute of the different human races. Naturalists have been much occupied with this subject, and I refer to their works.

In our climate the principal colours are black, flaxen and bright red. They are, as it were, the three general types to which may be referred many particular shades. The black has under it the brown, the chesnut, &c. The flaxen is connected on the one hand with the bright red and on the other with the chesnut. The bright red which touches the flaxen by one of its extreme shades, goes by an opposite shade to the natural colour of certain flames.

All physicians have considered the colour of the hair as among the characters of the temperaments. Black indicates strength and vigour. The figure of a wrestler with flaxen hair would be almost ridiculous. This colour is the attribute of weakness and delicacy; it floats upon the head of figures which painters have made strangers to the great passions, to powerful and heroic deeds; it is found upon the figures of young people, in pictures where laughter, sport, grace and pleasure preside over the subjects. These two colours, black and flaxen, as well as their secondary shades, are found distributed among women in nearly equal proportion; now reflect upon the kind of sentiment this sex inspires according to the colour of the hair, without regard to any other consideration, and you will see that a woman with flaxen hair creates a sentiment which beauty and weakness united seem to dictate. The epithets that we employ express this double attribute. On the contrary, the term brunette announces in her that it designates, a mixture of force and beauty. Beauty is then a common gift which attracts us, but which, differently modified by external forms, attracts us by touching, interesting and exciting us. Eyes in which langour is depicted, are frequently associated with flaxen hair; whilst black hair is almost always met with, in

those whose vivacity and sparkling seem to proclaim an excess of life which seeks to be diffused.

Habit which accustoms us to every thing, changes our taste in regard to the colour of the hair, as it does to that of our dress. Black, flaxen and their numerous shades are in turns fashionable in France; and as the organization does not change with our taste, we have contrived artificial hair; a happy means, which seems to subject to our inconstancy the invariable course of nature, and which, changing at our will the expression which the physiognomy borrows from the hair, can at every instant exhibit man under forms which fashion extols to day, and which ridicule pursues tomorrow. Now among these numberless variations which succeed each other among us in the fashion of the hair, bright red and its various shades never find a place. Most people have a decided aversion to it. It is almost, in our eyes, a mal-formation to be born with it. This opinion is too general not to have some real foundation. The principle appears to me to be the usual connexion between the hair and the temperament and of course the character which results from this; now the kind of character connected with this kind of hair is not commonly the happiest, though there are many exceptions to this principle, which is proverbial. Another reason for the aversion to hair of a bright red, is that the oily fluid which lubricates it often exhales a fetid odour foreign to the other kinds of hair.

What is the relation that can exist between the hair and the character? Has the first an influence upon the second? No; the following is the way in which it should be considered. Every man has his peculiar kind of organization and constitution. This forms the temperament; now, to each kind is attached on the one hand this or that species of hair, and on the other the predominance of some internal viscera, which though less apparent is not less real. This predominance disposes evidently to certain

passions, which are the principal attributes of character; then the colour of the hair and character are two different results from the same cause, viz. constitution; but one has no influence upon the other.

The hair coming out of the cutaneous pores has such a direction, that that of the anterior part of the cranium is almost always oblique in front, and tends to fall over the forehead; that of the middle and posterior part pierces the skin perpendicularly, and that of the posterior and inferior part traverses it obliquely, so as to fall naturally down the length of the posterior part of the neck. It is the same with that of the sides, which its direction as well as its weight, carries upon the region of the ear which it covers.

Eyebrows.

Upon the arch which borders the orbit above, is found a collection of hairs forming a portion of a circle more or less evident, which shades the eye and defends it from the too powerful impression of the rays of light. The hairs of the eyebrows are thicker together in persons of dark complexion, than in those of light. More numerous within, they sometimes unite together the two eyebrows upon the nasal prominence, and thus shade the root of the nose. Fewer without, they there cause the eyebrow to terminate in a point. All are obliquely directed from within outwards. Sometimes towards the internal side, they go perpendicularly forwards. Their length is scarcely more than half an inch; they do not exceed this except in some extraordinary cases. Their colour is usually, though not invariably, the same as that of the hair. They are firmer, more resisting and larger than the hairs of the head. If they were longer they would curl like the hairs on the genital parts, of the nature of which they partake.

The eyebrows enjoy two evident motions. 1st. They are depressed and carried inwards, by forming over the

eye a very evident arch. 2d. They are raised up and separated from each other, by expanding the parts around the orbit. The length between the extremes of these two motions is nearly an inch. The first motion takes place to defend the eye from a very bright light. It expresses also the melancholy and gloomy passions; hence the reason no doubt why the same word is applied to the moral state of the mind, and to the row of hairs of which we are treating. Observe on this subject that the sanguineous and choleric temperaments, which are the most disposed to the passions which make the eyebrows contract, are precisely those in which the hairs that compose them are found in general the most evident. The second motion enables us to receive upon the region of the orbit a great quantity of the rays of light; it allows us to raise the upper eyelid to a great extent in order to open the eye wide, which the first evidently prevents. It expresses also the gay passions, those which dilate the face. Painters have studied more than anatomists, the different degrees of elevation and depression of the eyebrows.

Eyelashes.

Upon both eyelids there exists a small row of hairs, a little longer than those of the eyebrows, of the same nature as them, directed obliquely forwards, crossing each other when the two eyelids are brought together, and serving to defend the eye from the small particles floating in the air. In general they do not curl; when they do and turn towards the eye, an irritation ensues, and they must be cut off. Sometimes a bad direction is the cause of this irritation.

I would remark on the subject of the eyelashes, that all the openings of communication with the interior, as those of the meatus auditorius externus, the nose and the anus, and oftentimes also the orifices of the lactiferous tubes, are surrounded with a great number of hairs which defend

these openings from external bodies. Around the mouth the beard takes the place of these hairs; the urethra has none, but the prepuce at its orifice is instead of them.

Beard.

The males of most animals are distinguished from the females by some external productions. The comb of the cock, the mane of the lion, the horns of the stag, &c. are examples of these distinctive characters. In man, the beard is the principal attribute of the male. It occupies all the chin, the sides of the face, both lips and the superior part of the neck. It leaves the cheeks bare as well as the parts around the eyes; thus observe that it is there that the passions are principally depicted, the expression of which would be concealed by the hairs, if the lower part of the face was the seat of them.

The beard, not so long in general as the hair of the head, is longer than that of every other part of the body. It is very commonly of the colour of the first, though more rarely flaxen and is more frequently of a bright red, which it often is in persons with flaxen hair. The nature of the hairs of the beard is the same as that of the hairs of the genital parts, the eyebrows, &c. They curl, are stiffer, more resisting and uniformly less oily than the hair of the head.

The quantity of beard varies remarkably in different men. Those in whom it is abundant and of a deep black are in general strong and vigorous. Observe also that the strongest males in the different species of animals are those, in whom the external production which distinguishes them from the females, is the most conspicuous. We might say that this characteristic production is the index of the strength or weakness of their constitution. A small lion has not a noble mane; great horns belong to a well made stag, and long, twisted ones to a good formed ram. Observe that it is not the same with the other hairs

common to the two sexes. Often in a weak man, those of the arms, the thighs, &c. are as evident and even more numerous, than in the most muscular.

The habit of cutting the beard as most Europeans do, of preserving it like the Asiatics and of dressing it in different ways like the Chinese, gives a different expression to the face which characterizes the people. A masculine, vigorous physiogomy which expresses strength and energy, cannot be deprived of this external attribute without losing a part of its character. That of the Orientals exhibits an appearance which coincides with the strength of their bodies, and forms a contrast with the effeminacy of their manners. I do not know if, in consulting the history of the different people who allow their beard to grow, and that of nations who cut it, we might not be tempted to believe that muscular force is to a certain extent connected with its existence, and that this force is always diminished a little when we are constantly deprived of it. Every one knows the vigour of the ancients, that of the people with long beards, and that even of certain men who, among us, allow their beards to grow in conformity with the laws of monkish institutions. No doubt many causes may make weakness exist with a beard; but in a general view I think we can admit that there is a certain relation between it and strength. Take from a cock his comb, which is the characteristic of the male, as the beard is that of man, and he will lose strength. I am persuaded that we might take from the lion a part of his power by taking away his mane. We know the result of the experiments of Russel upon the castration of stags; their horns, after this operation have grown in an irregular manner, or have not even grown at all. This external attribute of the male in this species, appears as we know at the period of virility, when the vital forces are increased. It is the same with the human beard. This coincidence would alone prove that the use of this

last is to serve for an external character to the male sex. The eunuch, whose powers are feeble, loses also oftentimes much of his beard.

Such are our prejudices in regard to the idea we form of beauty, that we ridicule what is really and absolutely so, for that is certainly so which indicates organic perfection. A peacock without his tail of emeralds, a ram or a stag without their horns, displease us; why does not man without his beard?

II. *Of the Pilous System of the Trunk.*

The hairs on the trunk are very variable. Some men appear as it were shaggy, whilst others are almost without hairs. There are more of them generally on the anterior than on the posterior part of the trunk. It is principally along the linea alba and upon the chest, that they are found in man. This last part is in general destitute of them in woman, who has usually very few on the trunk.

Both sexes have a very considerable quantity on the genital parts. They are there, as I have said, of the nature of the beard. Less frequently flaxen than the hair of the head, as frequently of a bright red, they are most usually black. They are, next to the beard, the longest hairs. They have generally no determinate direction; each hair almost has a different one. Few animals, like man, exhibit this excess of hair upon the genital parts. There is a great difference in individuals as to its quantity. The blackness and abundance coincide in general with strength.

III. *Pilous System of the Extremities.*

Man has many hairs upon the whole surface of his extremities. The proportion of number is nearly the same

in all; but the length varies very much; in some, they form only a down; in others, they are a little longer; whilst in others, they are nearly of an inch in length, reach over each other, and give the extremities a shaggy appearance.

At the top of the superior extremities, there is in the hollow of the axilla a collection of hairs which are longer than the others, and are nearly of the nature of those of the genital parts. Nothing similar is seen on the inferior extremities.

The pilous system does not exist on the internal part of the arm and fore-arm in many men, in whom we see it only behind and on the sides. It is more uniform on the inferior extremities. The back of the foot and hand always have hairs. They are never seen on the sole of the one or the palm of the other; a circumstance of essential advantage to the perfection of touch.

ARTICLE SECOND.

ORGANIZATION OF THE PILOUS SYSTEM.

WHATEVER varieties exist in the form, size and arrangement of the hairs, their organization is nearly the same in all. We shall now examine this organization in a general manner. Chirac, Malpighi and all anatomists since them, have explained very well in some respects, and very badly in others, the structure of the hairs of the head, which is nearly the same as that of all the other hairs. The following is what careful dissection has shown me concerning it.

I. *Origin of the Hairs.*

The hairs of the head, and in general all the hairs, arise from a sub-cutaneous fat, or the cellular texture of the parts which are destitute of this fluid. Each is contained at its origin, in a kind of small membranous canal, the nature of which is perfectly unknown to me, and whose transparent parietes allow the hair to be plainly seen, when we have separated them with a delicate scalpel from the surrounding parts. This small cylindrical canal accompanies the hair to the corresponding pore of the skin, insinuates itself into this pore, passes through it, extends to the epidermis and is intermixed there with the texture of this membrane, but goes no further. The length of this canal, and consequently of the course which the hair runs under and in the skin, is nearly five lines in the hairs of the head. There is no adhesion between the hair and the internal surface of this small canal, except at the enlarged base of the first where, it receives its nourishment. Thus, by opening the canal at this place, and destroying its adhesions there, the hair becomes free, and is drawn from without inwards with great ease, by taking hold of its enlarged end with small forceps. In this way, the canal is insulated. I have thus dissected and separated, upon a surface of two inches, a very great number of these canals which appear, when nothing but them is left on the internal surface of the skin, like so many small elongations of it.

Are there vessels and nerves in this small cylindrical sac which contains the origin of the hairs? We see distinctly elongations going to its external surface, especially towards its extremity opposite to the skin; but dissection does not teach us the nature of these elongations. I have never been able to trace them to a neighbouring vessel or nerve. Haller has not been more successful,

though he speaks of authors who have traced nerves to the origin of the hairs. I presume however that these elongations are especially vascular. Is there a fluid between the origin of the hair and its covering? By opening the latter, nothing escapes, though some authors have pretended the contrary. Besides, if this fluid is in the form of dew, as upon the serous surfaces, it cannot be distinguished.

It is in the middle of this small cylindrical sac, of which I have just spoken, that the origin of the hair is found. We see at its extremity an enlargement oftentimes almost insensible, at others very evident, though always less than has been said. This enlargement is of the same colour and nature as the hair itself. It adheres to the canal very probably by the vessels and perhaps the nerves it receives from it. The hair which arises from it goes through its canal without adhering, as I have said, to its parietes, passes with it through the oblique pore of the dermis, leaves it at the epidermis, and goes outward.

All authors say that the hair does not pierce the epidermis, but only raises it up, and that this forms a sheath which accompanies it to its extremity. This assertion is incorrect; in fact, 1st, the hair is as thick in its canal of origin as it is out of it. 2d. This canal being opened at its extremity opposite to the skin, we can draw out of it, as I have said, the whole hair with great ease, and without the least resistance; which would not be the case however if the covering of the epidermis was to be broken. It appears that from the enlargement of its extremity, the hair has no adhesion either in the subcutaneous canal, or in its passage through the skin, or the epidermis. 3d. If the cutaneous epidermis was raised up to cover the hair, this would have a treble thickness, unless this epidermis became wonderfully thin upon it. 4th. We do not see this pretended rising up by drawing out a

hair of the head; on the contrary a depression exists at the place where this comes out. The cutaneous epidermis furnishes nothing then to the hairs, though the nature of them may be in part the same as its own, and it is proper to consider them as uniform in their structure from one extremity to the other.

Under the skin, through it and out of it, the hair is composed of two distinct parts. One external, forms a canal which extends from the enlargement of the dermoid extremity to the opposite one; the other internal, which composes as it were the medulla of it, is of an unknown nature.

II. *External Covering of the Hairs.*

The external covering of the hair appears to be of the nature of the epidermis. It has in fact almost all the attributes of it. 1st. The hairs of the head burn exactly like this membrane, give out when burning an analogous odour, and leave after combustion a similar kind of coal; now it is principally to the external portion that these phenomena are owing. 2d. Water penetrates the hairs with great ease; hence very useful hygrometers can be constructed with them; now the same is true of the epidermis; and moistened hairs in foggy weather present in this respect a phenomenon analogous to that of the epidermis softened, wrinkled and whitened by the contact of a cataplasm. 3d. It is by means of the epidermoid covering that the hairs are foreign to life, that they are insensible and never become the seat of any acute or chronic affection. 4th. This covering is white, whatever may be the colour of the hairs. The cause of the colour resides in the internal medulla; thus the epidermis of negroes and that of white people differ but very little. Hence why when the internal substance of the hair has disappeared, the canal remaining alone exhibits a more or

less evident whiteness. 5th. In this state, though the interior of the hair may be dead, the epidermoid exterior, which is independent of it, preserves most commonly the faculty of growing when it is cut; thus the cutaneous epidermis is truly foreign to all the subjacent diseases of the skin. 6th. I presume that it is this covering which gives to the hairs of the head the property of remaining so long uninjured. When removed far from the access of the air, they remain unaltered for ages; they have not in them the principle of decomposition of the other animal substances. They never become putrid either in air or water. Thus we have seen that the cutaneous epidermis never undergoes putrefaction, which seizes upon the subjacent parts.

It appears however that the hairs are more unalterable than the epidermis, and that there is even a difference of nature between them. In fact, 1st, maceration and ebullition, which make the epidermis very easy to be broken, though they soften it but little, leave the hairs with their usual resistance, unless carried to degrees that I have not tried. By boiling and macerating them comparatively with the epidermis, we easily make this observation. 2d. The acids act less efficaciously upon the hairs than upon this membrane; but the alkalies dissolve them with as much and even more ease. 3d. A thread of epidermis of equal thickness would be incomparably less resisting than a hair. 4th. The hairs can, like the epidermis, be painted of different colours; but they do not retain them so long, and on this account the colour must be renewed oftener.

Some modern authors have said that there is detached from the external covering of the hairs a kind of scales which form as it were little branches to them. We do not see these elongations. However the experiment mentioned by Fourcroy, and which consists in this, that by rubbing a hair between the fingers, it is raised like the

heads of some species of grain in the direction from its base to its point, this experiment, I say, appears to prove the existence of these insensible elongations, which perform also an essential part in the adhesion of the hairs of the head to each other, an adhesion that is such that when they have remained a long time without being separated, as in long diseases, it is only done with the greatest difficulty.

Sometimes the hairs are bifurcated in a very evident manner at their extremity.

It is the greater or less thickness of the epidermoid covering of the hairs, which constitutes the different nature of them. Thick and compact on the genital parts, the chin, &c. it is less easily penetrated with water, and renders the hairs more elastic there and more capable of curling. Loose and thin in the hairs of the head, it makes them more smooth, and gives them more sensibly the property of the hygrometer. It is the peculiar nature of this external covering, which gives to the hairs of the head and the hair of negroes the character which distinguishes them.

From what we have just said it is evident that the external covering of the hairs of the head is the part of them which is essentially inert and foreign to life. It is not the same with their internal substance.

III. *Internal Substance of the Hairs.*

This substance is the most important; it is this which essentially characterizes the hairs, which I should have ranked in the epidermoid system, if they had nothing but their external covering, as is the case when they become white.

We are entirely ignorant of the nature of this internal substance. It can only be presumed that there are extremely delicate vessels inclosed in the common epider-

moid covering containing a colouring substance, which stagnates in these vessels, or at least is subjected in them to a very slow nutritive motion. Among these vessels, do any of them as on the skin, open outwards to throw off fluids? Many physiologists have thought so, and on this account they have considered the hairs as real emunctories. I do not believe that we have any anatomical data upon this point; but the plica polonica, a singular disease in which the hair when cut pours out blood, evidently proves that they have exhalants in a natural state, which then becoming enlarged and dilated, pour out a fluid that they before refused to admit. Besides, there is no doubt that the pilous exhalants, infinitely less active than the cutaneous, are a much less copious emunctory. As to the absorptions which some have pretended are made by the vessels of the hairs, I think that nothing can prove them.

From what we have just said upon the internal substance of the hairs, it appears that it has a true analogy with the reticular body of the skin, and that, like it, it arises from two sorts of vessels, one in which the colouring matter stagnates, the other which gives passage, in some cases at least, to fluids, and in which there is consequently a kind of circulation.

The colouring substance of the hairs has some analogy with that of the skin. Thus we observe that the first, like the second, is blacker in warm climates and nearer the equator than in colder ones; thus red hair is frequently found with freckles which are more or less abundantly spread upon the skin of some people, and which are evidently seated in the reticular body, as I have ascertained in many patients who had these marks, and in whom the epidermis was raised up either by erysipelas or a blister. The acids however change the colour of the hair more than they do that of the skin of negroes. The muriatic whitens at first the hairs of the head which

become yellow in drying; the nitric yellows, and the sulphuric leaves them black.

That which especially interests us in the internal substance of the hairs, is the real vitality which it enjoys, and which essentially distinguishes it from the external covering. It is to this character that must be referred the following phenomena.

1st. The different passions of the mind have a remarkable influence upon the internal substance of the hairs. Often, in a very short time, grief has changed the colour of it, and whitened it by occasioning no doubt the reabsorption of the fluid contained in the small capillary vessels. Many authors have related facts of this kind. Some, even Haller, have doubted them. But I know at least five or six instances in which a discoloration has taken place in less than eight days. The hair of a person of my acquaintance became almost entirely white in the course of a night upon the receipt of melancholy intelligence. In these changes, the epidermoid covering remains the same, preserves its texture, its nature and its properties; the internal substance only is altered. It is said that terror can make the hair stand an end; painters express it even by this external attribute; I know not to what extent we should give belief to this phenomenon which I have never seen; but it is an opinion too generally received not to have some real foundation. Now if fear acts so powerfully upon the hair, if it can give it a real motion, is it astonishing that grief and pain should suddenly change the fluids that are found in it, and deprive it even of these fluids?

2d. The plica polonica, of which I spoke just now, in which the hairs of the head become, when they are cut or even when they are not, the seat of a bloody exhalation, and in which they have a remarkable excess of life, evidently resides in the internal substance; the epidermoid covering has no connexion with it. Some authors even

say that this internal substance acquires sometimes a fleshy nature; then their covering is raised up in scales.

3d. We know the danger of cutting the hair after many acute diseases. I have already seen a melancholy instance of it. Many physicians, Lanoix in particular, have related others. Now, to what are these accidents owing? It is certainly not to the contact of the air, from which the hair defends the head; for these accidents take place, though the head may be covered. It can only be owing to this, that the growth of the hairs that are cut, calls to these organs a vital activity which the internal viscera soon sympathetically feel; hence the pains of the head, the affections of the eyes, &c. observed in these cases. It is a species of active sympathy exerted by the hair upon the viscera; now, every organ which sympathizes has a real vitality, and enjoys very distinct vital properties. The epidermis never takes part in sympathies, because it is almost completely inert, is hardly organized, is not at the level of the other organs, and cannot consequently correspond with them. The danger of cutting the hair after severe sickness, gives me opportunity to observe that it is often as dangerous to remove suddenly the vermin from the heads of children during these diseases. I have seen three or four instances of accidents from this cause.

4th. The hairs not only influence other systems, but are also influenced by them. This is what we often see after acute diseases, in which the roots sympathetically affected, repel the fluids that come to nourish them, die, and the hairs fall out. Observe that this falling out of the hair very rarely takes place at the same time with the desquamation of the epidermis; which proves, that the generally admitted opinion of the origin of the external covering of the hairs is entirely false, and that, though very analogous to the epidermis, this covering does not arise from it, as I have said.

5th. Many animals lose at one season of the year their hairy covering, which is afterwards reproduced; now the period of its regeneration is often that of many diseases, and almost always that of a greater weakness than at other times. We might say that the nutritive work which then calls to the exterior much vital force, diminishes this force in the other regions. Man is not subject to these annual renewals of the external productions which cover his body, like birds, many quadrupeds, reptiles, &c. It is a cause of less diseases. In fact, a thousand different causes would no doubt have frequently deranged these renewals in society, as a thousand causes disturb the menstrual evacuation, &c.; hence the various diseases we escape by the want of this renewal. Man is in general subjected to fewer causes of natural revolutions, than most animals.

6th. Heat and cold have also oftentimes an influence upon the internal substance of the hairs. We know that in some animals, as rabbits, hares, &c. they become white in the winter and resume their original colour in the summer.

7th. A short time after painting the hairs of the head black, a fashion now more common in France than at the period in which they powdered them, there is often experienced pains in the head and a swelling of the hairy scalp, though the skin has been in no way concerned, has not been pulled, and the hair only has been affected.

It follows from all we have just said, that the hairs analogous, by their external covering, to the epidermis; foreign by means of it, if we may so say, to life, belong to it much more particularly by their internal substance, a substance whose nature is yet but little known, as I have already said. What moreover evidently proves this assertion, is that the phenomena of which I have just spoken, and to which I could add many others, cease to be evident in persons, in whom the hairs having become white,

have no longer any thing but the epidermoid covering, the internal substance having in part disappeared ; particular observation proves this. It may be however that in this case that portion alone of this internal substance, corresponding to the colour, is destroyed, whilst that which is the seat of the exhalations continues to live as usual ; and, in this respect, white hairs may experience vital phenomena, of which, I believe, there are a few examples. But all this is subordinate to the future experiments, which will elucidate the pilous structure more than it now is.

ARTICLE THIRD.

PROPERTIES OF THE PILOUS SYSTEM.

The hairs experience but a slight degree of the horny hardening when exposed to the action of caloric. They then turn in various directions, curl and twist ; but this arises from a cause entirely different from that of the horny hardening of the other organs. The caloric then removes the moisture with which the hairs are constantly penetrated, and thus approximates their particles. Thus when the hair is moistened by fog, a bath, &c. the curls disappear. The oily substances that are used at the toilet, give a coat that is insoluble in water, and preserve the curling, by preventing it from penetrating the hairs. Some time after the head has been washed, they curl more, as we have had occasion to observe since the Grecian head dresses have been in fashion among us. This

at first appears to be contradictory, but it is not so. In fact by then rubbing the hairs much, the unctuous substance is removed, which always surrounds them, or this substance combines with the soap, if the water contains it, as is often the case; by this means it easily penetrates the hairs, the pores of which remain open, and by afterwards evaporating with the fluids that were already there, and which the unctuous substance retained, it leaves these organs more dry than they were, and consequently more disposed to curl.

A proof, that it is the epidermoid covering which thus imbibes the moisture that it afterwards loses in the state which succeeds the curling, is, that the detached epidermis can be curled with a hot iron, and afterwards rendered supple by soaking it in water.

The contractility and extensibility of texture are very indistinct in the hairs; it is their resistance which prevents their rupture; they can hardly be stretched at all.

They have no animal sensibility when pulled; the pain that arises from it has its seat especially in the skin through which they pass. Thus when drawn opposite to their direction, we suffer much more than by stretching them in the direction of their pores. I do not deny however that these elongations, which fix their origin to the neighbouring parts, may be also the seat of pain when the hairs are pulled. These organs have no animal contractility.

The organic properties certainly exist in their internal substance. The changes which this substance undergoes can only depend on the different alterations which affect these properties. The organic sensibility and the insensible contractility especially are raised in it in a remarkable degree in the plica polonica; now in order to have the degree of energy which they then do, they must have existed there in a natural state. It is these two properties, that, the sympathies of which we have spoken,

put into action. The organic contractility is nothing in the hairs.

Yet we cannot deny that in the natural state, these organs are, next to the epidermis and the nails, those in which life is the least active, those which have the least numerous relations with the other organs. Whilst every thing is destroyed in most of the other systems by diseases, this is most often unaffected by them ; it grows as usual, and appears to be in no wise disturbed ; it has then a manner of being, of existing, wholly different from the others.

In general, the external productions of animals, as the feathers, the hair, the scales, &c. seem to form a separate class of organs, foreign to the life of the internal organs ; it is almost like the different species of mosses that grow upon trees, without making essentially a part of them.

ARTICLE FOURTH.

DEVELOPMENT OF THE PILOUS SYSTEM.

I. *State of this System in the First Age.*

In the first months of the fœtus there are no hairs on the skin which is then gelatinous. It is when the fibres of the dermoid texture are formed, that there begins to appear on the head a light down, an indication of the hairs which are afterwards to arise. This down is whitish and concealed by that fatty and unctuous substance, which

we have said is deposited on the external surface of the skin at this age. Soon this down, which appears to be but the external covering of the hairs, which is then of extreme tenuity, begins to be coloured black or flaxen, according to the tint that is afterwards to predominate; it is the internal substance that forms it. The colour remains faint until after birth. At this period the hairs are often more than half an inch long. Upon all the rest of the body there is only the down, the precursor of the hairs; the face especially has much of it. The hairs of the head are then in advance at one period of the other hairs, in their growth.

After birth the hairs grow much more rapidly than before. It is precisely the reverse of most of the other parts, whose growth is more rapid in the womb of the mother. During the whole of youth this system has a tint less deep, than it is afterwards to have. The flaxen becomes nearer the chesnut, and this nearer black, and the first tints of the bright red grow many degrees darker towards the period from the twenty-sixth to the thirtieth year. The light tints are to the pilous system in youth, what the imperfectly developed forms are to the muscular, cellular, &c. Oftentimes that which is to be afterwards flaxen, approaches a whitish tint, which is owing only to the nature of the internal substance, and not to its absence in old age. Thus the white of the Albinoes depends also upon the peculiar species of this internal substance. Many hairs are wanting upon the body of the young man.

II. *State of the Pilous System in the following Ages.*

At puberty there is a remarkable revolution in this system which becomes almost double. The hairs of the genital parts are formed; the beard which is, as I have said, the characteristic attribute of the male in the human species, is also then developed. We might say that there

was the same relation between the hairs of the neighbourhood of the testicles and those of the beard, as between the testicles themselves and the organs of the voice, between the womb and the mammæ. The beard is, in this respect, the external sign of virility. Some time before it comes out, we see under the skin the sac which contains the origin of the hairs ; it is already very evidently formed, and permits the principle of the organ to be seen which it is to contain, as I have oftentimes ascertained ; thus the sac of the tooth exists a long time before the tooth is cut.

At the same time the hairs of the axilla grow also ; those of the trunk and extremities, which were then almost in a state of down, become larger, assume a determinate colour, and increase even much in number.

Why does puberty occasion this general growth in the pilous system ? This is asking the reason of all the other phenomena which appear at this period. I would only observe that the hairs of the head, the eyebrows, the eyelashes and the hairs at the openings of the body, are those which are the least affected by this revolution. Besides, this growth is gradual ; it requires at least two or three years for the beard to become what it is always to be.

In the following ages the hairs undergo but few changes ; they grow in proportion as they are cut in different parts, and are the seat of a constant external work ; now, observe that this work is more prompt, and the growth of the hairs consequently more rapid, in summer in which the cutaneous organ is especially in action, than in winter in which it is contracted ; an additional proof of the real vitality of the organic forces of the internal substance of the hairs.

III. *State of the Pilous System in Old Age.*

Towards the end of life, the pilous system is affected by the general obliteration which takes place in almost all

the external vessels; it ceases at first to receive the colouring substance. The internal substance dies, the epidermoid covering remains alone; the hairs become white. The hairs of the head appear the first, and are the first to die. The beard, the hairs of the genital parts and then those of all the parts of the body afterwards die. Besides, there is a great variety among men as it respects the period in which the hairs whiten; in some, this phenomenon begins about the thirtieth year, and even sooner, in others it is towards the fortieth, fiftieth or sixtieth. A thousand causes arising from the passions of the mind, from diseases, aliments, &c. can have an influence in society upon this premature death, so common in many men, but which does not take place in animals, who are not exposed from their kind of life, to the same revolutions, until the last years.

The hairs, after remaining white for a longer or shorter time, finally fall out; then the sac which covered the origin of them flattens down and entirely disappears. I have examined many bald heads; the skin of the cranium was perfectly smooth on its internal surface, though it had been separated from the cellular texture. No trace is discoverable there of the innumerable appendices which the canals form, after the hairs they contain have been drawn inwards. I have also dissected a man who after a putrid fever had become almost entirely bald. There were all these little canals entire, and in the bottom of them could already be seen the rudiments of new hairs. There is then this difference between the falling out of the hairs of old people, and that which is the consequence of diseases, that every thing dies in the first, because the vessels which go to the root cease to transmit fluids to it; whereas in the second case the hair alone falls out, and its sac remains.

It is a pretty generally received opinion that the hair, the nails and the epidermis continue to grow after death.

We have, I think, but few data respecting this singular phenomenon. I am however certain that I observed a real elongation of the hairs of a chin of a head that had been carefully shaved, and which I macerated eight days in a cellar. An attendant of the dissecting room, who prepares many heads for the bones, informed me that he had often made the same remark, when putrefaction is prevented for some time. What is certain also is, that the growth of the beard is not in the direct ratio of the vital forces; in the diseases which affect these forces with a general prostration, it grows as much as in those in which there is a general exaltation of these forces. We remark this in hospitals where at the side of an inflammatory fever, there is often found a putrid or slow nervous one. Besides, why should there not be sufficient tonic forces left in the hairs to grow some time after general death, as there is in the lymphatics to absorb, &c.?

The different phenomena which the hair, the epidermis, the skin, and in general all the external organs experience in the successive ages, are wholly owing, like those of the internal organs, to the laws of nutrition, and not to the action of surrounding bodies. This is an essential difference between organic and inorganic bodies. The latter are gradually altered in two ways by the contact of external bodies which act upon them, 1st, mechanically by friction, tearing, &c. &c.; 2d, chemically, by combining with them, as for example, the air whose different principles undergo many combinations which change its nature and that of the bodies with which it is in contact. In this respect all inorganic bodies grow old. At the end of some time, they have no longer the exterior which characterized them in the beginning. Observe monuments, pictures, engravings, earths, metals, stones, &c. &c. every thing which in the arts, commerce, sciences, in the uses of life or in the phenomena of nature is formed of any inert bodies, whether these bodies have never lived, or having

lived, have not been able to preserve themselves after death, as the solid portions of vegetables, the bones, the horns, the hair of animals, &c. every thing finally has the indelible stamp of time; every thing grows old; every thing loses its freshness, every thing changes on the exterior of inert, as well as on that of organic bodies; but as in the first surrounding bodies alone have acted, the internal partis still young, whilst the external is old, if I may be allowed to use two very improper words. Thus the rock whose surface is blackened by the lapse of years, is the same in the interior as when it was created. On the contrary in animals and vegetables, the internal organs are worn out, as well as the exterior. Time is marked upon the viscera, as well as upon the forehead of the aged. Surrounding bodies act upon us, wear out life, if we may so say; but it is as stimuli that they exert their action; it is by exhausting the sensibility and contractility, and not by combination, mechanical contact or friction. Language ought to express this difference. We do not use the term *young* when viewing the exterior of a new building, a new garment, or a picture recently painted; why do we say an *old* monument, an *old* piece of cloth, &c.? if it is a metaphor, very well; but this word cannot express a state analogous in its nature, to that of an old animal, an old plant, &c.

IV. *Preternatural Development.*

There are three principal cases in which the hairs are preternaturally developed in the economy.

1st. Sometimes they are formed on the internal surface of the mucous membranes; they have been seen in the bladder, the stomach and the intestines; many authors have given cases of them. I have found them upon the calculi of the kidney. I have seen in the gall-bladder at one time a dozen of nearly an inch in length, and which were evidently implanted in its surface.

2d. There is often seen on the skin preternatural collections of them, which are usually a defect from birth. These collections are particularly observed upon some of those productions or irregular excrescences, that are called nævi materni. There was exhibited at Paris, six years since, an unfortunate person, who had from his birth his face covered with hairs almost like those of a wild boar; and to whom there came on at the age of thirty-six years, that particular species of elephantiasis, in which the skin of the face increased in size, exhibits, if we may so say, the features of the lion, a species which I have since had occasion to observe upon a natural skin. This double circumstance gave to the face of this man an air of ferocity which it is impossible to describe. Many of the stories circulated by the vulgar concerning men with the heads of wild boars, bears, &c. are nothing but these nævi in the face, with a growth of hair upon them.

3d. Hairs are often preternaturally developed in cysts, in those of the ovaria especially. A great many instances have been related. Haller in particular has collected many; I have seen two. The following is what they exhibit; a considerable large sac contained many very distinct small balls, analogous to those of the dung of sheep, formed by a fat, unctuous, whitish substance, very different in its appearance from ordinary fat. On the internal surface of this sac were implanted many hairs, which the least force could remove, because they hardly penetrated below the surface. These hairs were black. Many already detached were found crossed in different directions, in the small balls of fatty matter, which was like spermaceti; for it very much resembled the substance into which the fat is changed by maceration.

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